# 10. NOISE & VIBRATION

## 10.1 Introduction

### 10.1.1 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.
- Post-completion noise impacts on surrounding receptors.
- Post-completion vibration impacts on surrounding receptors.
- Noise impacts within the completed development from external sources ('inward impacts').

Following a preliminary scoping exercise, considering the nature of the proposed development (i.e. residential development and linear park along the Trusky stream) it was concluded that the proposed development will not give rise to any vibration impacts following commissioning, and this category has therefore been scoped out. The remaining four categories are assessed in this chapter.

### 10.1.2 Methodology

Typical ambient noise levels at the site were measured to establish a baseline and these were used to identify appropriate construction phase noise criteria. Likely construction plant were identified, and their noise emissions data 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 vibration during the construction phase were identified, and impacts assessed by reference to commonly applied criteria.

Noise sources associated with the commissioned development were reviewed, and potential impacts assessed. In line with emerging best practice, an assessment of inward noise impacts was undertaken, and the requirement for enhanced façade treatments was assessed.

### 10.1.3 Documents consulted

This chapter was prepared in accordance with the guidance identified in Chapter 1, where relevant. The following documents were consulted during the preparation of this chapter:

- Report 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).
- NANR116: Open/closed window research – Sound insulation through ventilated domestic windows (prepared by the Napier University Building Performance Centre for Defra, 2007).
- 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).
- Design manual for roads and bridges (UK Highways Agency, 2011).

- 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).
- British Standard BS 8233:2014 Guidance on sound insulation and noise reduction for buildings (2014).
- Good practice guidance for the treatment of noise during the planning of national road schemes (National Roads Authority (now Transport Infrastructure Ireland), 2014).
- Galway County Council – Preliminary appraisal report – N6 Galway City outer bypass (ARUP, 2014).
- Technical guidance document TGD-021-5: Acoustic performance in new primary & post primary school buildings (Department of Education & Skills, 2015).
- Draft advice notes on current practice in the preparation of environmental impact statements (Environmental Protection Agency, 2015).
- Galway County Council Development Plan 2015-2021 (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).
- ProPG Planning & noise: Professional practice guidance on planning & noise – New residential development (Association of Noise Consultants, Institute of Acoustics & Chartered Institute of Environmental Health, 2017).
- Environmental noise guidelines for the European Region (World Health Organisation, 2018).
- Galway Noise Action Plan 2019-2023 (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).

### 10.1.4 Competence of assessor

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 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–: Principal at Damian Brosnan Acoustics.

## 10.2 Guidance & criteria

### 10.2.1 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 at 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 relevant to most of the construction phase. However, this criterion is considered overly onerous with respect to landscaping works proposed around the margins of the site, in proximity to offsite receptors, particularly as (a) such works will be short term, lasting no more than several hours or several days at any position, and (b) landscaping works will benefit nearby offsite receptors in the long term. For such works, an $L_{Aeq\ 1\ h}$ limit of 70 dB is considered suitable, derived from 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). The daytime 70 dB criterion recommended in the NRA document is commonly applied to non-road projects in the absence of any other Irish guidance.

The 65 dB main works criterion, and the 70 dB landscaping criterion, are considered applicable to surrounding receptors, in their immediate curtilage

As construction projects tend to be relatively short, and as construction works areas are usually localised and mobile, the 65 and 70 dB limits are usually not subject to any additional criteria such as tone and impulse restrictions.

### 10.2.2 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 10-1 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 10.1 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. |
| 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 NRA's 2014 document with respect to construction vibration has seen increasing application to non-road projects due to the absence of any other Irish guidance. NRA criteria, listed in Table 10-2, 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 10.2 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 10-3. 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 10.3 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).*

## 10.2.3 Post-completion noise

There are no national mandatory noise limits applicable to commissioned developments. While a number of guidance documents have been issued with respect to certain sectors, none relate to residential developments such as those assessed in this report. The only potential noise impact associated with the commissioned development relates to potential local increases in traffic volumes. Local offsite receptors are currently subject to existing traffic noise levels on the surrounding road network. The proposed development is likely to increase traffic volumes locally, with a consequent increase in traffic noise levels. The Design manual for roads and bridges (UK Highway Agency, 2011) notes that the resulting noise impact is linked to the magnitude of the noise increase. Table 10-4 sets out the DMRB guidance. Included in the table are impact categories listed by the EPA in their 2017 document Draft guidelines on the information to be contained in environmental impact assessment reports (Environmental Protection Agency, 2017).

*Table 10.4 Noise criteria appropriate to traffic noise increases*

| Noise level increase | Subjective reaction | DMRB impact | EPA impact |
|---|---|---|---|
| 0 dB | None | No change | Neutral |
| 0-3 dB | Imperceptible | Negligible | Imperceptible to not significant |
| 3-5 dB | Perceptible | Minor | Not significant to slight |
| 5-10 dB | Up to a doubling of loudness | Moderate | Slight to moderate |
| >10 dB | Doubling of loudness or greater | Major | Significant to profound |

In 2018, the World Health Organisation issued updated noise guidance for environmental noise in Europe (Environmental noise guidelines for the European Region). The document includes guidance in relation to road traffic noise, with the following recommendations:

- For average noise exposure, the Guideline Development Group strongly recommends reducing noise levels produced by road traffic below 53 dB Lden, as road traffic noise above this level is associated with adverse health effects.
- For night noise exposure, the Guideline Development Group strongly recommends reducing noise levels produced by road traffic during night-time below 45 dB Lnight, as night-time road traffic noise above this level is associated with adverse effects on sleep.

It is noted that the 53 $L_{den}$ and 45 dB $L_{night}$ criteria recommended in the 2018 document are lower than criteria set out in other documents. In this regard, the 2018 guidelines are considered aspirational, and are likely to form the basis of national and local policy over the next two decades.

## 10.2.4 Inward noise

The assessment of inward noise impacts on proposed residential developments is a relatively new feature in the Irish planning system, and no national guidance has been issued to date. In the absence of Irish guidance, assessments are typically undertaken in accordance with UK guidance. Most UK assessments are now carried out using ProPG Planning & noise: Professional practice guidance on

planning & noise – New residential development (2017), jointly issued by the Association of Noise Consultants, the Institute of Acoustics and the Chartered Institute of Environmental Health. ProPG provides for good acoustic design through a five step process:

- Stage 1: Initial noise risk assessment of the proposed development site.
- Stage 2 element 1: Demonstrating a good acoustic design process.
- Stage 2 element 2: Observing internal noise level guidelines.
- Stage 2 element 3: Undertaking an external amenity area noise assessment.
- Stage 2 element 4: Consideration of other relevant issues.

The noise risk procedure is summarised in Figure 10-1.

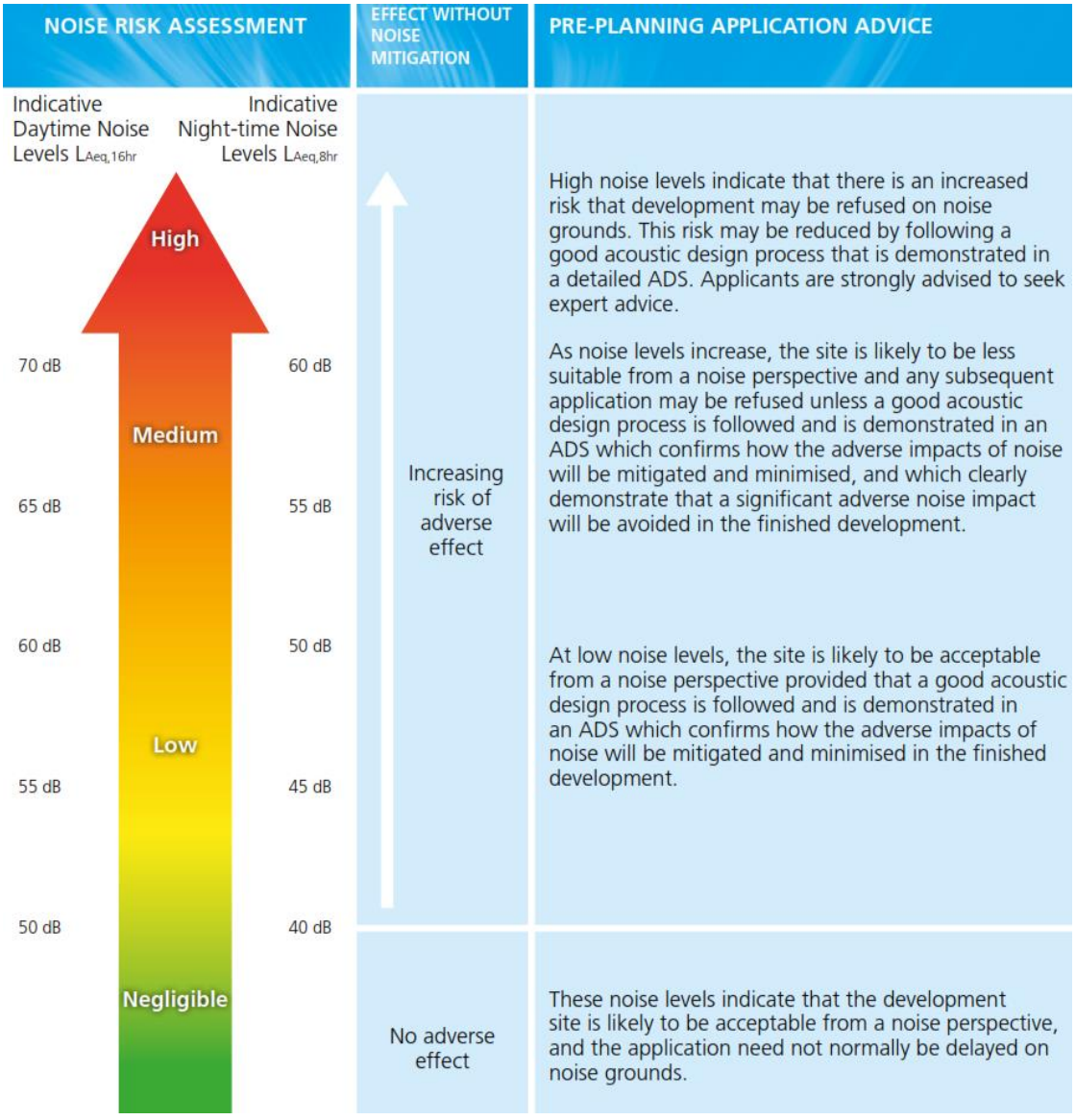


*Figure 10.1 Initial risk assessment from Pro-PG. ADS = acoustic design statement*

Internal noise guidelines recommended by ProPG, drawn from British Standard BS 8233:2014 Guidance on sound insulation and noise reduction for buildings (2014), are presented in Table 10-5.

*Table 10.5 Recommended internal criteria from BS 8233:2014 and ProPG*

| Activity | Location | 0700-2300 h | 2300-0700 h |
|---|---|---|---|
| Resting | Living room | $L_{Aeq\ 16\ h}$ 35 dB | - |
| Dining | Dining area | $L_{Aeq\ 16\ h}$ 40 dB | - |
| Sleeping or daytime resting | Bedroom | $L_{Aeq\ 16\ h}$ 35 dB | $L_{Aeq\ 8\ h}$ 30 dB |

BS 8233:2014 adds that:

> *Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,F}$, depending on the character and number of events per night. Sporadic noise events could require separate values.*

ProPG adds further advice here:

> *In most circumstances in noise-sensitive rooms at night (e.g. bedrooms) good acoustic design can be used to that individual noise events to not normally exceed 45 dB $L_{AmaxF}$ more than 10 times a night. However, where it is not reasonably practicable to achieve this guideline then the judgement of acceptability will depend not only on the maximum noise levels but also on factors such as the source, number, distribution, predictability and regularity of noise events.*

With respect to external amenity areas such as gardens in the curtilage of dwellings, BS 8233:2014 states:

> *For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq\ T}$, with an upper guideline value of 55 dB $L_{Aeq\ T}$ which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such a city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable noise levels in these external amenity spaces, but should not be prohibited.*

With respect to the proposed creche, BS 8233:2014 does not include recommendations, instead referring to local departmental guidance. In Ireland, such guidance is set out in Technical guidance document TGD-021-5: Acoustic performance in new primary & post primary school buildings (Department of Education & Skills, 2015). No guidance specifically exists with respect to creches. The document includes the following guidance in relation to schools:

> *Where it has been decided that the location for the school site is within a zone in excess of 50 dB $L_{den}$ on the relevant Noise Map, then the advice of an acoustic consultant must be obtained as part of the design process. To meet the [relevant criteria], it may be necessary to undertake acoustic testing of the site and external environment and to implement mitigating measures as outlined below through the building design. With regard to noise infiltration from external sources, in all cases designers should be cognizant of ambient noise levels around the particular site and employ cost neutral measures such as careful siting of the building within the overall site area available, using boundary treatments, landscaping measures, car parking and play areas as acoustic buffers. The location of the teaching spaces within the building*

*relative to the noise source, with care in orientation of windows and openings, should all attempt to mitigate noise infiltration.*

An $L_{Aeq\ 30\ min}$ limit of 35 dB indoor ambient is recommended with respect to school rooms used for teaching purposes. Where this can be achieved with windows closed, external $L_{Aeq\ 30\ min}$ levels of 51-55 dB (range dependent on ventilation type) are satisfactory at the location of proposed windows. The document sets out additional criteria related to noise insulation, and these will be adhered to at final design stage.

### 10.2.5 Development plan

The Galway County Council Development Plan 2015-2021 (2015) includes two objectives in relation to noise as follows:

*Objective TI 12 – Noise*

*Require all new proposed development, which is considered to be noise sensitive within 300 m of existing, new or planned national roads, or roadways with traffic volumes greater than 8,200 AADT, to include a noise assessment and mitigation measures if necessary with their planning application documentation. The cost of mitigation measures shall be borne by the developer. Mitigation measures in order to protect the noise environment of existing residential development will be facilitated or enforced as necessary.*

DM standard 24 of the development plan includes a similar requirement:

*Require all new proposed development, within 300 m of roadways with traffic volumes greater than 8,220 AADT, to include a noise assessment and mitigation measures if necessary with their planning application documentation.*

The proposed development site does not lie within 300 m of any roads with greater than 8,200 AADT. The nearest road of significance is regional route R336 which runs 320 m to the south. Traffic count information presented in Galway County Council – Preliminary appraisal report – N6 Galway City outer bypass (ARUP, 2014) predicts that the R336 AADT will reach approximately 16,000 in 2034.

### 10.2.6 Noise action plan

The Galway Noise Action Plan 2019-2023 (2019) produced by Galway County Council 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. This includes regional route R336 near the proposed development site.

The noise action plan proposes that mitigation will be applied where $L_{den}$ levels exceed 70 dB, and $L_{night}$ levels exceed 57 dB. The plan includes several stipulations with respect to noise sensitive land uses (libraries, hospitals, nursing homes, schools, etc.) in areas subject to high noise levels, and with respect to development facing major roads. None of these is considered relevant to the proposed development, as baseline noise data indicate that the site is not subject to high noise levels.

## 10.3 Baseline

### 10.3.1 Location & land use

The proposed development site consists of a 5.38 ha plot, located approximately 400 m northeast of Bearna village (Figure 10-2). The site does not directly adjoin any public roads, and is accessed from local primary road L1321 to its west via Cnoc Fraoigh, a small residential estate of 21 detached dwellings.

The southwest side of the site directly adjoins Cnoc Fraoigh. The northern half of the western boundary adjoins a mixture of gardens and fields. The northern, eastern and southern boundaries adjoin agricultural land. The site is currently under a mixture of rough grazing and disturbed ground. Ground elevation rises gently northwards.

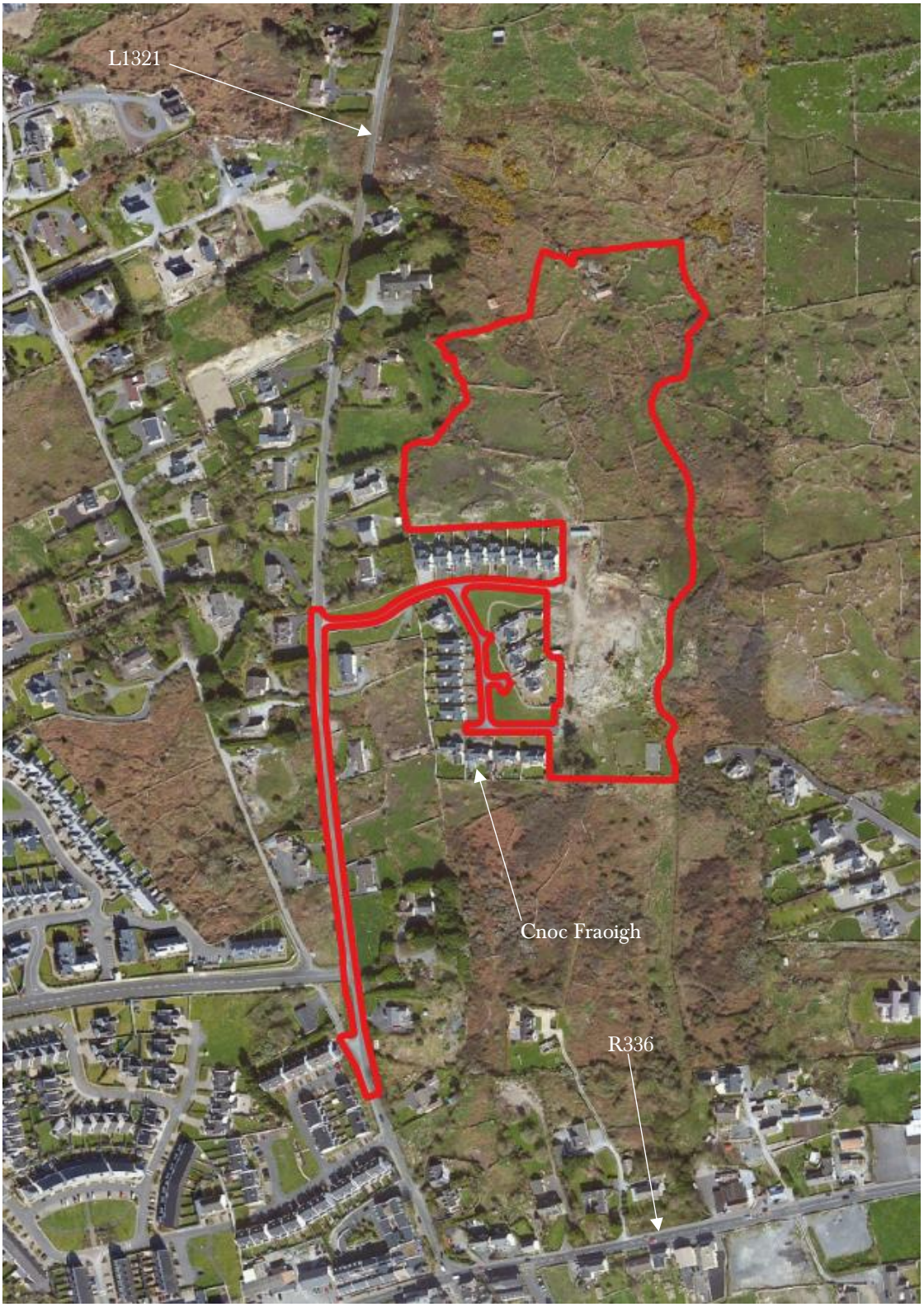


*Figure 10.2 Site location N*

### 10.3.2 Receptors

There are no noise receptors on the proposed development site itself. Being on the fringes of Bearna village, the site lies in proximity to a large number of receptors as follows:

- At Cnoc Fraoigh, the rear and/or side gardens of 12 dwellings adjoin the site boundary.
- A combination of residential estates and one-off dwellings extends along the L1321. The rear gardens of three dwellings here adjoin the site boundary. Two dwellings further north lie close to the northwest corner.
- Scattered dwellings are located to the northwest and east, 250-300 m from the boundary.
- A residential development to the southeast approaches the southeast corner, with the nearest dwelling here located 30 m from the corner.

There are approximately 50 dwellings within 200 m, most of which are located at Cnoc Fraoigh, at an extensive residential cluster further west, or at the residential development to the southeast. No particularly sensitive receptors such as care homes are located in proximity to the site.

### 10.3.3 Noise mapping

Round 3 noise maps relevant to the study area were reviewed. Road traffic noise maps pertain to the area; rail and aircraft noise maps are not relevant. Traffic noise maps are shown in Figures 10-3 and Figure 10-4. The maps indicate that the study site is not significantly affected by R336 traffic noise. $L_{den}$ and $L_{night}$ levels are considerably lower than action criteria set out in the Noise Action Plan.

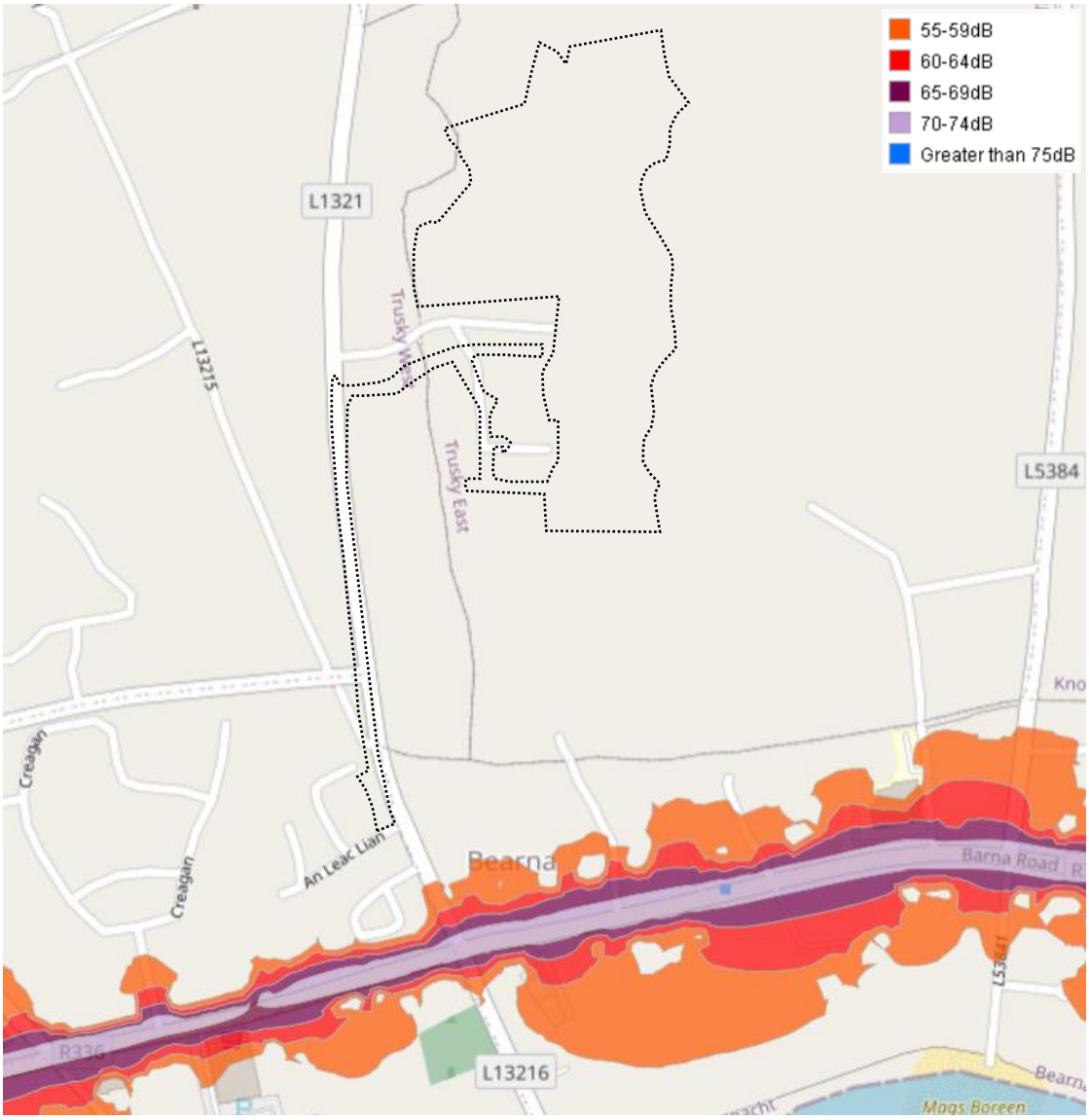


*Figure 10.3 Round 3 noise mapping road $L_{den}$ contours, with applicant's holding outlined black N*

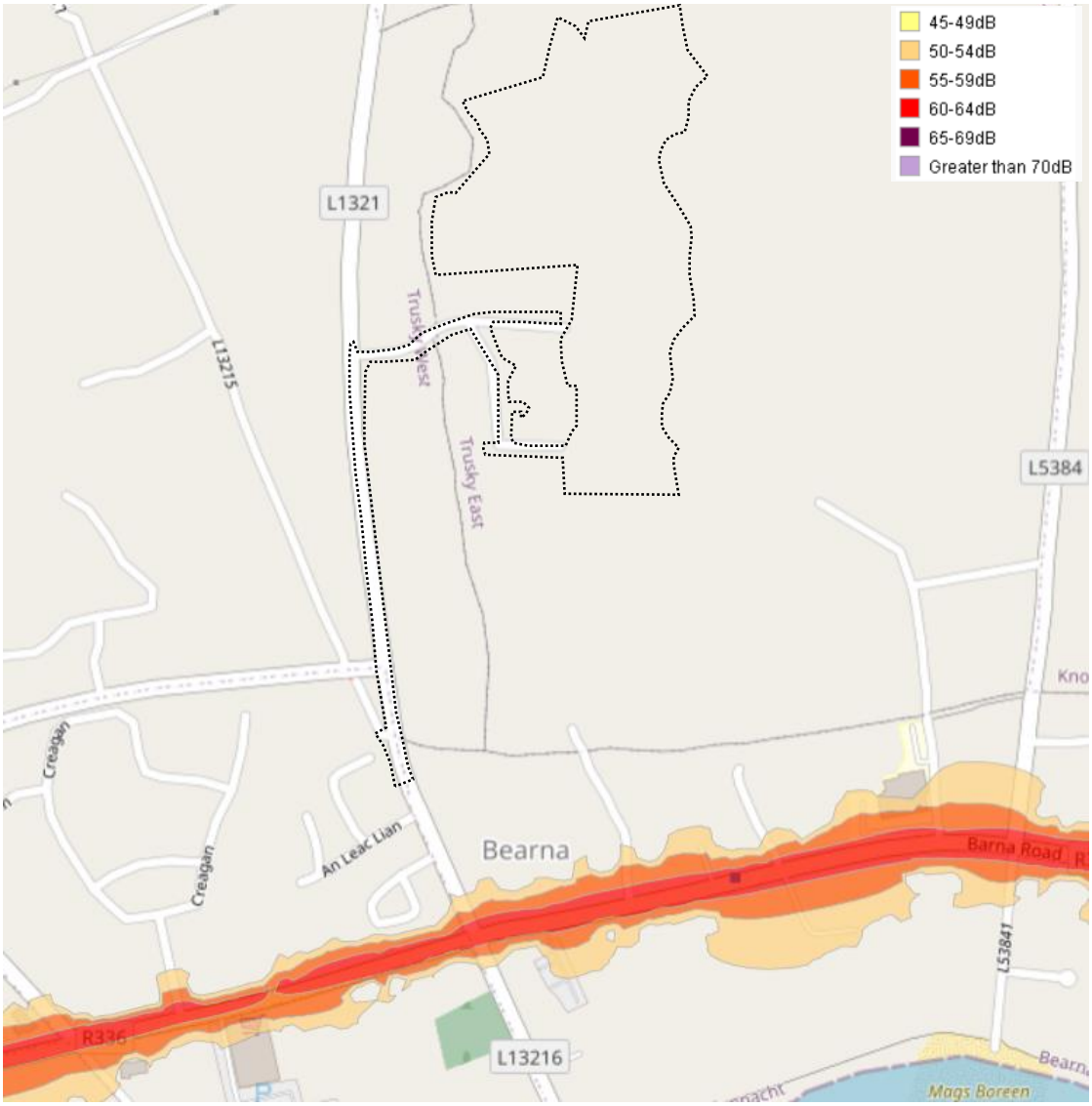


*Figure 10.4 Round 3 noise mapping road $L_{night}$ contours, with applicant's holding outlined black N*

## 10.3.4 Noise survey

A baseline noise survey was carried out at the proposed development site over the period 09.09.20 to 10.09.20. The purpose of the survey was to provide up to date ambient noise data at the site. Monitoring was carried out at two onsite locations (N1 and N2) shown in Figure 10-5 and Plate 10-1 and Plate 10-2, and described in Table 10-6. The survey consisted of a mixture of unattended and attended monitoring. Survey methodology, equipment specifications and weather conditions are listed in Appendix 10-1. The recorded time history profile at the unattended station N1 is shown in Figure 10-6. Noise data are presented in Table 10-7.

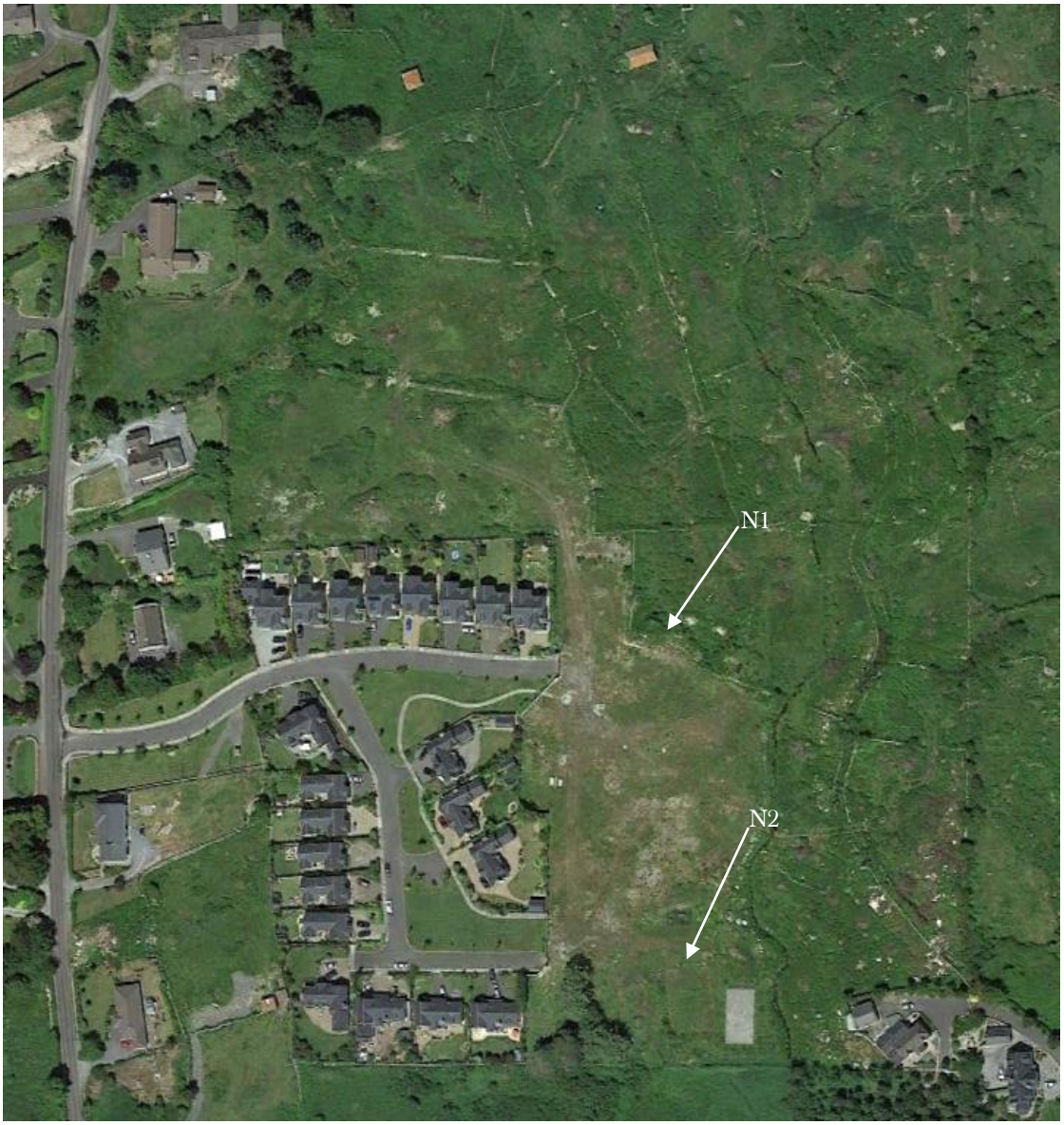


*Figure 10.5 Baseline noise stations*

*Plate 10.1 N1, looking NW.*

*Plate 10.2 N2, looking NW.*

*Table 10.6 Noise stations*

| Station | NGR | Reason for selection |
|---|---|---|
| N1 | 523242 723457 | To provide an indication of the baseline 24 h soundscape across the site |
| N2 | 523242 723330 | To confirm that the baseline station is representative of the southern end of the site |

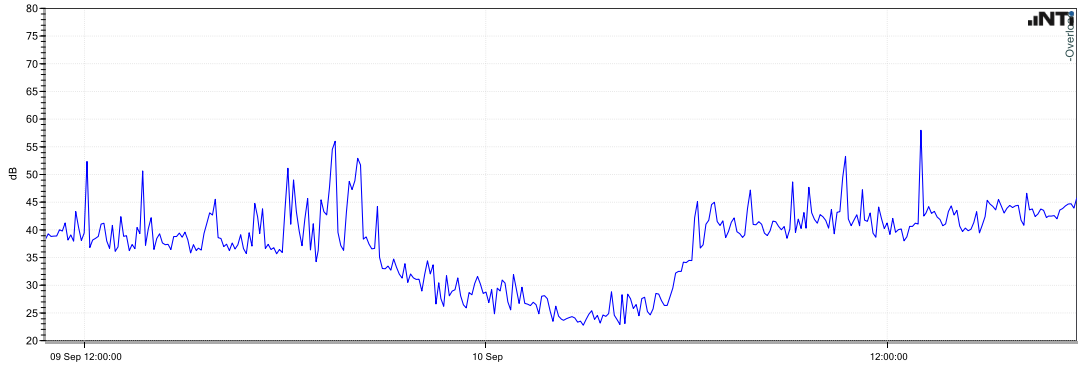


*Figure 10.6 $L_{Aeq\ 1\ s}$ profile at N1*

*Table 10.7 Noise data summary*

| Station | Time | $L_{Aeq\ 1\ h}$ | $L_{AF10\ 1\ h}$ | $L_{AF90\ 1\ h}$ |
|---|---|---|---|---|
| N1 | 1100-1200 | 40 | 41 | 35 |
| N1 | 1200-1300 | 43 | 40 | 34 |
| N1 | 1300-1400 | 43 | 41 | 35 |
| N1 | 1400-1500 | 38 | 40 | 35 |
| N1 | 1500-1600 | 40 | 41 | 33 |
| N1 | 1600-1700 | 38 | 40 | 33 |
| N1 | 1700-1800 | 41 | 41 | 32 |
| N1 | 1800-1900 | 45 | 42 | 31 |
| N1 | 1900-2000 | 49 | 45 | 32 |
| N1 | 2000-2100 | 46 | 41 | 29 |
| N1 | 2100-2200 | 33 | 36 | 26 |
| N1 | 2200-2300 | 31 | 34 | 25 |
| N1 | 2300-0000 | 29 | 31 | 25 |
| N1 | 0000-0100 | 29 | 31 | 24 |
| N1 | 0100-0200 | 27 | 29 | 24 |
| N1 | 0200-0300 | 24 | 25 | 23 |
| N1 | 0300-0400 | 25 | 27 | 23 |
| N1 | 0400-0500 | 27 | 29 | 23 |

| | | | | |
|---|---|---|---|---|
| N1 | 0500-0600 | 31 | 34 | 24 |
| N1 | 0600-0700 | 42 | 43 | 31 |
| N1 | 0700-0800 | 42 | 43 | 36 |
| N1 | 0800-0900 | 41 | 42 | 37 |
| N1 | 0900-1000 | 44 | 43 | 37 |
| N1 | 1000-1100 | 46 | 44 | 38 |
| N1 | $L_{den}$ | 45 | - | - |
| N1 | $L_{Aeq\ 16\ h}$ | 43 | - | - |
| N1 | $L_{night}$ | 34 | - | - |
| N2 | 1015-1115 | 39 | 42 | 35 |
| N2 | 1658-1758 | 45 | 47 | 43 |

The main noise source audible at both stations was distant road traffic, with intermittent L1321 traffic. Data suggest that ambient noise levels are relatively consistent across the site. A significant increase at N2 during the final measurement was linked to a rising breeze. $L_{den}$ and $L_{night}$ levels at the site are considerably lower than the respective 70 and 57 dB thresholds set out in the Galway Noise Action Plan 2019-2023 (2019) with respect to traffic noise mitigation.

### 10.3.5 Soundscape sensitivity

Noise data recorded above may be used to assess the sensitivity of the local soundscape in the context of criteria set out in several documents as follows:

- 2018 WHO guidance recommends that $L_{den}$ and $L_{night}$ levels should not exceed 53 and 45 dB respectively in order to minimise health and sleep effects. Data measured onsite indicate that $L_{den}$ and $L_{night}$ levels are significantly below these criteria.
- Measured $L_{Aeq\ 16\ h}$ and $L_{night}$ levels indicate that the site is negligible risk in the context of Pro-PG. In this regard, no adverse effects are expected.
- Pro-PG recommends that the number of $L_{AFmax}$ events above 45 dB in bedrooms should not exceed 10 at night. This equates to an external criterion of 60 dB, based on a 15 dB reduction through an open window, which in turn is based on the 12-18 dB range reported in NANR116: Open/Closed Window Research – Sound Insulation Through Ventilated Domestic Windows (prepared by the Napier University Building Performance Centre for DEFRA, 2007) with respect to road traffic noise. Recorded noise data indicate that there were no $L_{AFmax}$ events above 60 dB during the night-time, apart from several local spikes in the early morning linked to local birdsong.
- BS 8233:2014 recommends an external $L_{Aeq\ T}$ criterion of 50 dB is spaces such as gardens. Data indicate that this criterion is comfortably met across the site.

- At the site of the proposed creche, external $L_{Aeq\ 30\ min}$ levels do not exceed the 51-55 dB range recommended by the Department of Education & Skills with respect to windows and the internal 35 dB criterion.
- $L_{den}$ and $L_{night}$ levels across the site are lower than action criteria set out in the local authority Noise Action Plan.

### 10.3.6 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 semi-rural in character, with the chief background noise sources being local and distant traffic. In the medium term, traffic volumes are likely to increase across the study area, due to continuing development in Galway and Bearna. However, traffic noise levels are unlikely to increase given the expected gradual replacement of the national car fleet with electric vehicles. Given that roads in proximity to the site are subject to speed restrictions, the dominant component in local traffic noise is engine and transmission emissions rather than tyre noise, and such emissions are substantially lower in electric vehicles.

With respect to the development site itself, it is expected that, should the proposed development not proceed (the 'do nothing' scenario), no noise emissions are expected to arise other than those from land management practices, depending on how the site is used into the future.

## 10.4 Noise emissions

### 10.4.1 Proposal summary

It is proposed to construct a mixture of detached, semi-detached, terraced, duplex and apartment units across the site, albeit concentrated in the northern half. The number of residential units will total 121. Apartment blocks will extend to three floors, and will be provided with balconies. A creche will be provided at the site centre. The site will be served by a network of onsite roads. Open spaces will be landscaped. Vehicular access to the development will be provided through the adjacent Cnoc Fraoigh estate. The proposed layout is shown in Figure 10-7.

Construction will be undertaken on a phased basis, beginning within six months of grant of planning permission, and will be managed from a temporary onsite compound. Initial construction works will involve demolition of several small structures scattered around the site, including an existing wastewater treatment plant at the southeast corner. The overall construction project is expected to last four years. Construction hours will be 0800-1800 h Monday-Saturday.

*Figure 10.7 Proposed layout*

## 10.4.2 Construction noise sources

Construction works will include the following activities, undertaken variously throughout the construction phase and in different areas of the site:

- Demolition of existing structures.
- Soil stripping & temporary stockpiling.
- Installation of temporary site compound.
- Provision of hardcore stone on onsite roadways.
- Excavation of dwelling foundations.
- Excavation of ground services trenches.
- Installation of services including sewerage network.
- Pouring & floating of concrete floor slabs.
- Block work and roof work.
- Building finishing (windows, doors, etc.).
- Laying of asphalt.
- Site landscaping.

During the construction phase, the chief source of noise emissions will be plant used onsite. Construction plant required onsite at various stages of the project are listed in Table 10-8. The table includes details of typical sound pressure levels, taken from BS 5228-1:2009+A1:2014. Breaking of concrete may be required during the initial demolition works.

*Table 10.8 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 $L_{Aeq}$ |
|---|---|---|---|---|---|---|---|---|---|
| Asphalt paving machine with tipper truck | 78 | 77 | 72 | 72 | 71 | 69 | 62 | 56 | 75 |
| Discharging concrete mixer truck | 80 | 69 | 66 | 70 | 71 | 69 | 64 | 58 | 75 |
| Tracked excavator (16 t) | 78 | 70 | 72 | 68 | 67 | 66 | 73 | 65 | 76 |
| Excavator with breaker | 88 | 88 | 86 | 89 | 83 | 83 | 80 | 76 | 90 |
| Consaw | 73 | 67 | 70 | 68 | 73 | 78 | 78 | 77 | 84 |
| Mobile generator | 78 | 71 | 66 | 62 | 59 | 55 | 56 | 49 | 65 |
| Dumper | 84 | 81 | 74 | 73 | 72 | 68 | 61 | 53 | 76 |
| Vibro-roller | 88 | 83 | 69 | 68 | 67 | 65 | 62 | 59 | 74 |
| Telescopic handler | 85 | 79 | 69 | 67 | 64 | 62 | 56 | 47 | 71 |
| Truck (driving) | 73 | 78 | 78 | 78 | 74 | 73 | 68 | 66 | 80 |

Noise emissions arising during the construction phase of the proposed development will vary considerably due to several reasons:

- Emissions will arise from plant operating across the site, and thus the site will not constitute a single point source.
- The large construction area will result in differing propagation conditions with respect to receptors at different locations.
- The construction phase will last several years. During this time, plant associated with different activities will relocate around the site as required.
- Different plant will be required at different times, and construction operations will vary on a daily basis. There may be extended periods during the construction phase with minimal noise emissions.
- Each machine item may operate under different loading conditions or be in varying states of repair.
- Construction works may be concentrated for certain periods, followed by periods of seeming inactivity. Localised works may require several hours of intense activity.
- During later stages of the construction phase, emissions from some operations will be screened by previously completed buildings.
- As buildings near completion, activity will gradually relocate indoors.
- With respect to particular plant, the models selected will change depending on requirements. The method of construction may be modified shortly before commencement, resulting in the need to import different equipment. Construction projects tend to be fluid in nature, with plant requirements changing as the site is progressed and circumstances change on the ground. The need for specific plant may often be established only following the start of a project.

From the foregoing, it is clear that construction phase noise emissions will vary, and it is not possible or practical to calculate a single sound power output figure for the entire site. With respect to surrounding noise sensitive receptors, worst case scenario emissions will arise when localised works are undertaken close to their respective boundaries.

### 10.4.3 Construction vibration sources

Potential sources of groundborne vibration during the construction phase are as follows:

- Delivery truck movements: Trucks may give rise to vibration at positions adjacent to the roadway. However, such emissions are typically imperceptible beyond several metres, and are highly unlikely to perceptible at dwellings alongside the roadway.
- Plant movements: The movement of plant onsite is not considered to constitute a source of groundborne vibration, and is not listed in typical vibration documents such as BS 5228-2:2009. In addition, plant machinery used onsite is likely to be small to mid-sized, and similar to those used on other urban construction projects.
- Ground works: Excavation of trenches and pits for foundation and services will be required. These activities are not typically associated with offsite ground-borne vibration impacts. It is noted that piling is not proposed.
- Concrete breaking: Unlike the activities listed above, breaking involves a direct and repetitive impact to structures which may transmit into the underlying rock stratum, thus potentially generating relatively high levels of ground borne vibration locally. However, such vibration tends to contain relatively little energy in the lower frequencies at which buildings and occupants are most vulnerable. In addition, higher frequencies attenuate more rapidly than low frequencies, thus minimising the impact zone. For this reason, most vibration guidance documents such as BS 5228-2:2009 ignore concrete or rock breaking vibration. Table 10-9 lists various PPV levels reported in literature at sites where

hydraulic rock breaking has been undertaken. The range in levels noted reflects variations in equipment power and rock type.

*Table 10.9 Reported rock breaking PPV levels (various sources)*

| At 5 m | At 10 m | At 20 m | At 50 m |
|---|---|---|---|
| 0.2-4.5 mm/s | 0.06-3.0 mm/s | 0.02-1.5 mm/s | 0.1-0.3 mm/s |

Vibration levels reported above in relation to rock breaking are significantly lower than criteria listed in Tables 10-1, 10-2 and 10-3. Given that concrete breaking does not involve direct breaking to rock, vibration levels associated with the former are likely to be lower again. Thus concrete breaking, if required, is unlikely to give rise to perceptible groundborne vibration at offsite receptors. It follows that construction operations are unlikely to be perceptible offsite, or to cause cosmetic or structural damage to buildings.

### 10.4.4 Post-completion noise sources

Apart from the proposed creche, the entire development will consist of residential units accessed by a network of roadways. Noise emissions from these will arise from typical residential estate sources such as playing children, lawnmowers and car movements. Emissions will also arise from vans associated with deliveries, and waste collection trucks. All such emissions are highly unlikely to be significant onsite or offsite. Onsite traffic speeds will be low, thus minimising tyre noise.

The proposed site layout will incorporate open spaces which will be grassed and planted with trees. It is likely that a maintenance contract will be awarded to a local landscaping company. Maintenance activities undertaken at the proposed site will chiefly include regular mowing of open green areas. While mower emissions are likely to be audible at the nearest receptors, such emissions will blend into the urban soundscape, particularly during the summer when the daytime/evening noise environment in any urban area tends to include at least one mower audible in the distance at any time.

The proposed development will give rise to increased traffic on the local road network. Traffic movements on the main Cnoc Fraoigh thoroughfare will also increase as a result of the proposed development.

## 10.5 Potential impacts

### 10.5.1 Overview

As identified above, several sources are highly unlikely to give rise to offsite impacts. These are as follows:

- Construction phase activities are not expected to give rise to perceptible groundborne vibration at offsite receptors.
- Similarly, the completed project will not give rise to groundborne vibration.
- Following completion, noise emissions arising within the site will be urban-residential in character, and will not give rise to offsite impacts.

In contrast, potential impacts may arise with respect to three sources, and these are discussed below:

- Construction phase noise emissions may affect offsite receptors.
- Following completion, traffic noise levels on surrounding roads will increase, resulting in noise impacts.

- Residents at the proposed development may receive inward impacts, due to offsite road traffic noise.

## 10.5.2 Construction phase noise

Construction noise emissions will vary in time and location, and it is not possible to determine a single overall noise output figure for the construction phase. The most appropriate approach here is to assess worst case scenario emissions related to two works zones, based on their proximity to existing receptors. The zones are shown in Figure 10-8. Zone 1 relates to dwelling construction in proximity to the nearest receptors at Cnoc Fraoigh. Zone 2 lies at the southern end of the site, where wastewater treatment plant demolition and surrounding landscaping will require use of larger plant.

In zone 1, the following sources are likely to operate at intervals:

- Tracked excavator.
- Discharging mixer truck.
- Consaw.
- Telescopic handler.
- Truck.

A potentially-required concrete breaker will represent the source of greatest potential significance at zone 2. Noise emissions from these 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).
- Partially soft ground assumed throughout.
- No screening.
- Receiver height: 2 m (to assess external levels).
- Levels not rated for character.
- Plant output data taken from Table 10-8.
- 31.5 Hz levels (not provided in BS 5228) assumed to be same as 63 Hz levels.
- Plant on-times per hour: excavator (80 %), mixer truck (50 %), consaw (10 %), handler (20 %), breaker (80 %).
- Trucks following haul route from road entrance.

The model output is shown in Figure 10-9 and Figure 10-10. During most works, $L_{Aeq\ 1\ h}$ levels at surrounding receptors will remain lower than the 65 dB criterion recommended by BS 5228-1:2009+A1:2014. Certain landscaping works may require operation of plant close to the site boundary, in proximity to dwellings outside the boundary. $L_{Aeq\ 1\ h}$ levels associated with such works will not exceed the 70 dB criterion recommended by the National Roads Authority (now Transport Infrastructure Ireland).

Modelling indicates that concrete breaking near the southeast corner will result in elevated noise levels at the nearest receptors. At the closest dwelling to the southeast, the received $L_{Aeq\ 1\ h}$ level may marginally exceed the 70 dB criterion considered applicable to this activity. The level predicted here is 71 dB. It follows that mitigation will be required here for the duration of this activity. It is noted that this activity is likely to take less than one day

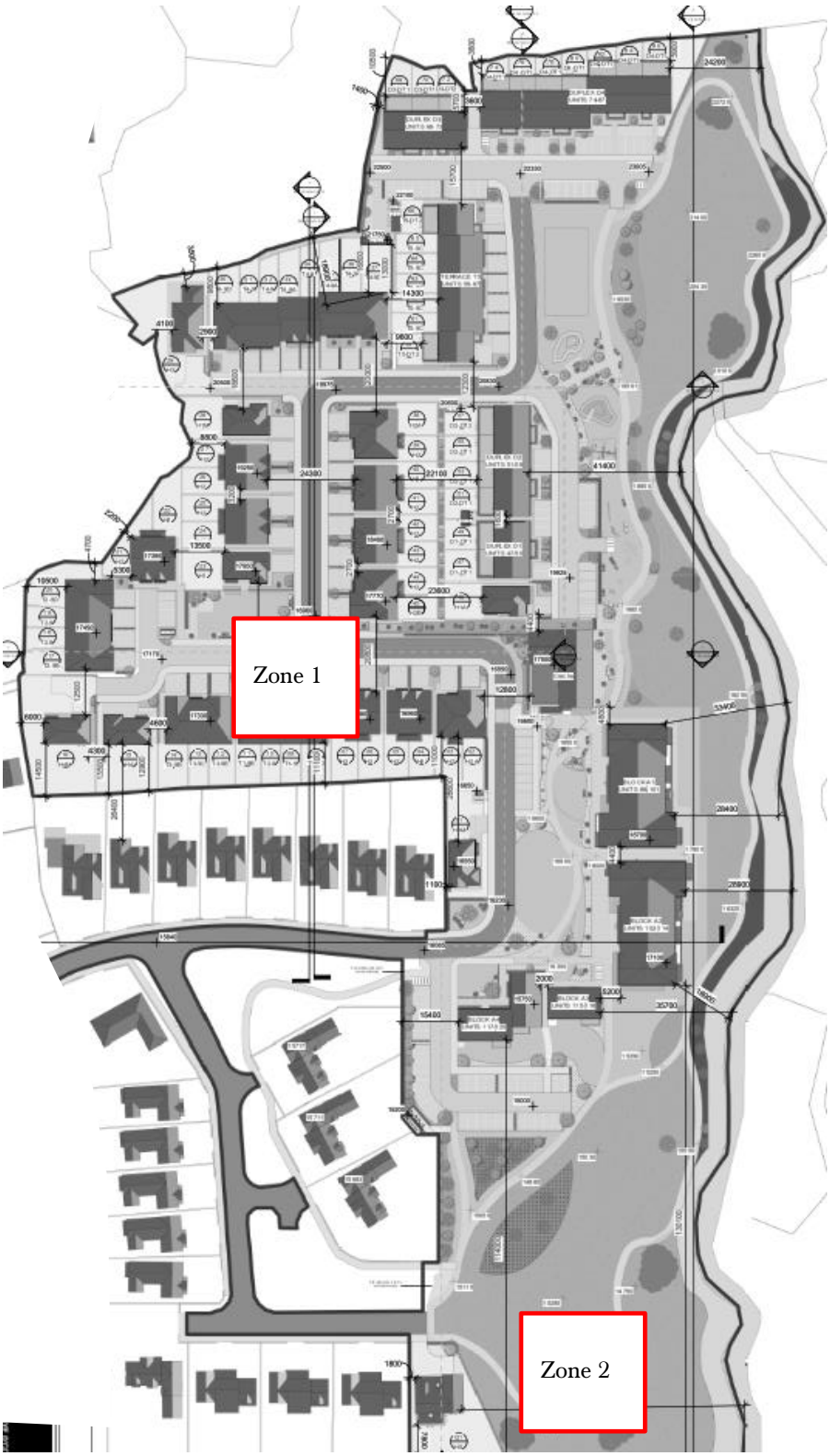


*Figure 10.8 Potential worst case noise zones during construction phase*

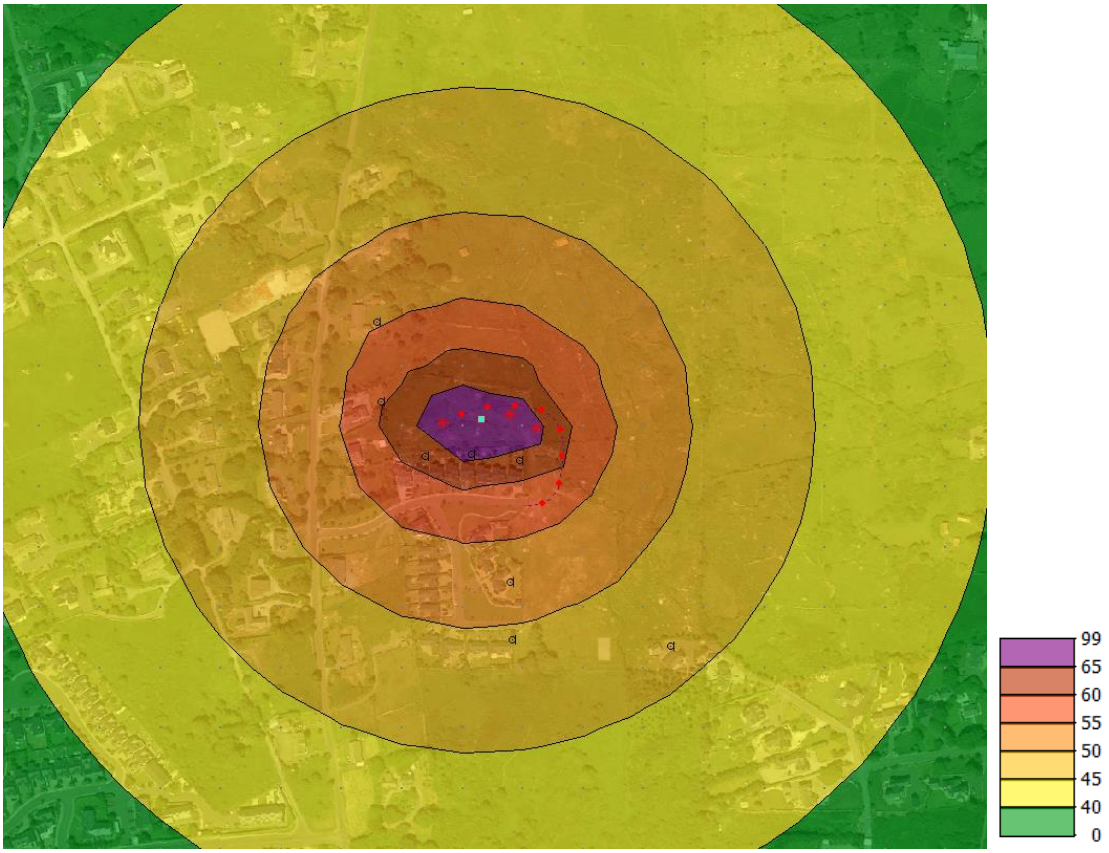


*Figure 10.9 Construction phase $L_{Aeq\ 1\ h}$ levels – likely worst case scenario – zone 1*

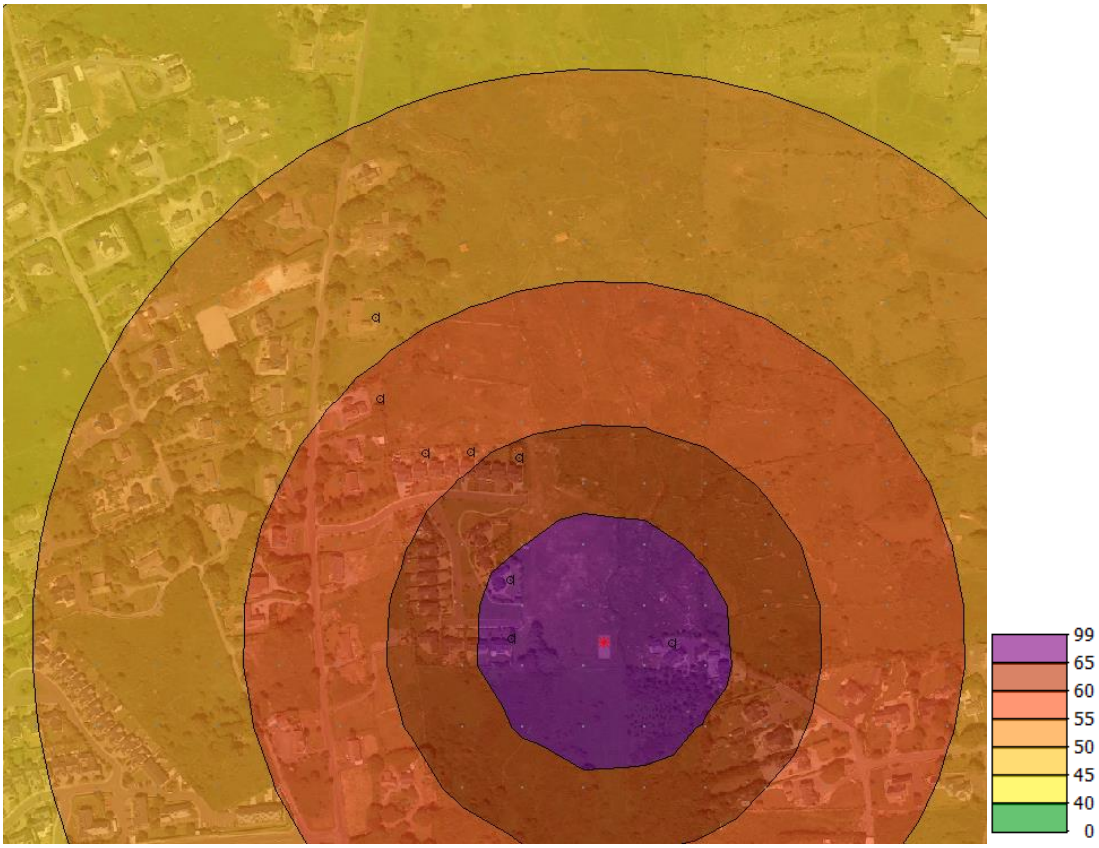


*Figure 10.10 Construction phase $L_{Aeq\ 1\ h}$ levels – likely worst case scenario – zone 2*

BS 5228:2009+A1:2014 data suggest that construction phase emissions will not be tonal. Apart from hammering and breaking, emissions are also unlikely to be impulsive. Hammering will be sporadic, typically occurring during roofing, and scaffolding erection and dismantling. Associated noise emissions will be brief and localized. Concrete breaking will also be impulsive, albeit confined to less than one day.

It is reiterated here that, throughout most of the construction phase, received $L_{Aeq\ 1\ h}$ levels are likely to be considerably less than the 65 dB criterion. On this basis, construction phase noise levels are likely to be short-term and slightly adverse at worst.

Throughout the construction phase, vehicles will arrive at, and depart from, the site during the working day. Vehicle movements will be associated with workers' arrival and departure, and delivery of materials. The approximate numbers of workers employed onsite over the entire construction period will fluctuate depending on schedules. Numbers are unlikely to exceed 30 at any time, due to project phasing. All personnel and deliveries will access the proposed development site via Cnoc Fraoigh, resulting in a temporary increase in local traffic volume. The increase will be moderate negative and short term within the residential estate. On the L1321, construction traffic volumes are expected to be inconsequential in the context of existing traffic volumes.

## Mitigation

Construction phase $L_{Aeq\ 1\ h}$ levels will be generally lower that the 65 dB criterion recommended by BS 5228-1:2009+A1:2014, and the 70 dB criterion recommended by the National Roads Authority (now Transport Infrastructure Ireland). During concrete breaking at a wastewater treatment plant near the southern boundary, $L_{Aeq\ 1\ h}$ levels at a dwelling to the southeast may marginally exceed the 70 dB

criterion. Given that this activity is unlikely to extend beyond one day, it is considered that the most suitable mitigation measure here is direct liaison with the dwelling occupants in order to agree a suitable period in which to undertake this activity.

No further construction phase measures are specifically required. The following general mitigation measures are proposed in order to minimise impacts at the nearest dwellings, particularly those at Cnoc Fraoigh:

- Construction operations will in general be confined to the period Monday-Friday 0800-1900 h, and Saturday 0800-1600 h.
- Where it is proposed to operate plant during the period 0700-0800 h, standard 'beeper' reversing alarms will be replaced with flat spectrum alarms.
- Hooting will be prohibited onsite. Drivers of plant and vehicles will be instructed to avoiding hooting at all times.
- Plant used onsite during the construction phase will be maintained in a satisfactory condition and in accordance with manufacturer recommendations. In particular, exhaust silencers will be fitted and operating correctly at all times. Defective silencers will be immediately replaced.
- Queuing of trucks outside the site entrance will be prohibited.
- A site representative will be appointed as a liaison officer with the local community. Prior to commencement of construction, contact details for the officer will be circulated to all local residents. The officer will notify local residents of upcoming works phases and likely noise sources.
- All complaints of noise received during the construction phase will be logged in a register, and investigated immediately. Details of follow-up action will be included in the register.
- Where it is proposed to import potentially noisy plant to the site, the potential impact of noise emissions will be assessed in advance.
- Guidance set out in BS 5228-1:2009+A1:2014 with respect to noise control will be applied throughout the construction phase.
- Throughout the construction phase, vehicles accessing the site will be subjected to a low speed restriction through Cnoc Fraoigh in order to reduce traffic noise.

### Residual Impact Assessment:.

Construction operations will be short term. Residual noise impacts during the construction phase from onsite activity will be moderate negative short term during periods of activity in proximity to surrounding receptors. There will be extended periods where impacts will be neutral to slight negative, depending on works. Construction traffic through Cnoc Fraoigh will give rise to moderate negative short term impacts at Cnoc Fraoigh dwellings.

### Significance of Effects:

Construction phase effects will be short term moderate negative.

## 10.5.3 Post-completion road traffic noise

Noise impacts at most offsite receptors attributable to car movements on roadways within the completed site are expected to be negligible due to a combination of low traffic speeds, low numbers of movements, screening by buildings and separation distance.

A review of the traffic impact assessment report indicates that the increase in L1321 traffic as a result of the proposed development will be small, resulting in a negligible increase in traffic noise. The change in traffic volume required to increase the $L_{Aeq\ T}$ level by 3 dB, which is the smallest change perceptible by the human ear, is 100 % i.e. traffic needs to double before the listener concludes that noise levels have increased. L1321 traffic increases will be minor, and resulting impacts will be imperceptible to not significant.

The proposed development will result in a considerable increase in traffic movements through the main Cnoc Fraoigh avenue, with a consequent increase in local traffic noise levels at dwellings alongside the avenue. Three considerations apply here:

- Traffic speeds on the avenue will be low, and no emissions will arise from tyre rolling noise. Emissions will arise solely from engine and transmission noise. Such emissions are absent in electric vehicles. The increasing proportion of electric vehicles will minimise increases in local traffic noise levels at Cnoc Fraoigh.
- The proposed development includes several features to enhance and promote sustainable transport options such as walking and cycling. These include incorporation of cycle paths into the design, adequate bicycle storage facilities, and proposals to upgrade walking connections to Bearna village.
- The proposed development will be contiguous with the Cnoc Fraoigh development. The layout of Cnoc Fraoigh was designed so as to facilitate subsequent extension into the proposed development site at some point, and it is reasonable to conclude that the proposed site was earmarked for further development following completion of Cnoc Fraoigh, and was zoned accordingly. Information submitted to Galway County Council as part of planning applications 03/4315 and 04/3846, both of which relate to the Cnoc Fraoigh estate, indicated that the lands to the east of Cnoc Fraoigh would be developed as phase two, subject to a separate planning application. Thus the proposed development, while not nominally representing phase two of Cnoc Fraoigh, will be contiguous with Cnoc Fraoigh as originally envisaged. In this context, the movement of vehicular traffic through a previously completed estate as a result of construction of a new estate represents an established pattern of residential development.

### Mitigation:

No mitigation measures are specifically required with respect to the completed development, other than implementation of speed restrictions on internal roadways in order to minimise traffic noise emissions.

### Residual Impact Assessment:.

On the basis of the above, the increase in local traffic noise, although measurable, is likely to be consistent with local soundscape context, thus minimising impacts. Context forms a key element in the assessment of noise impacts, as set out in *British Standard BS 4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound* (2019). With respect to traffic noise impacts resulting from site traffic through Cnoc Fraoigh, such traffic will be in keeping with residential estate context, thus minimising impacts. On this basis, it is concluded that traffic noise impacts at dwellings along the Cnoc Fraoigh main avenue will be slight to moderate negative. Impacts at all other receptors will be neutral.

### Significance of Effects:

The significance of effects will be slight to moderate negative and permanent at Cnoc Fraoigh, confined to a small number of dwellings in proximity to the main Cnoc Fraoigh avenue. Effects at all other receptors will be neutral.

## 10.5.4 Inward impacts

Inward impacts relate to noise immissions received at a receptor due to emissions emitted by one or more sources. Emerging best practice provides for the design of new developments such that occupants are not subject to high immissions from existing (and potential future) offsite noise sources. Such sources usually consist of transport (road, rail and aircraft), and industry. Internal and external criteria considered appropriate to new residential developments are identified in Section 10.2.4.

At the proposed development site, inward immissions arise from distant traffic on the L1321 and R336. Noise levels measured at the site indicate that noise immissions from these roads are minimal at the development site, and the site is deemed negligible risk in the context of Pro-PG. Measured $L_{den}$ and $L_{night}$ levels are low, and considerably below action criterion set out in the Galway Noise Action Plan 2019-2023. This is unlikely to change in the future.

Given the site's negligible noise risk, an acoustic design statement is not required. No specific noise mitigation measures are warranted with respect to inward noise immissions. Installation of standard glazing and ventilation will allow internal noise levels to readily comply with criteria set out in BS 8233 and Pro-PG, and no further treatment is required. Any increases in L1321 or R336 traffic in the future are highly unlikely to alter the site's negligible noise risk status.

At the proposed creche, incident $L_{Aeq\ 16\ h}$ levels will not exceed the 51-55 dB range suggested by Technical guidance document TGD-021-5, and thus standard glazing and ventilation will also achieve a satisfactory internal noise environment here.

**Mitigation:**

No mitigation measures are required with respect to the completed development. An assessment in accordance with Pro-PG indicates that the site is negligible risk with respect to road traffic noise, and is likely to maintain this status into the future. Internal $L_{Aeq\ T}$ criteria will be met at all residential units and at the creche using standard thermal glazing.

## 10.5.5 Population & human health

The assessment of impacts of noise on human health is typically undertaken by reference to WHO guidance, which has been revised over the last four decades as noise and health studies have been published. The latest WHO guidance with respect to community noise was issued in 1999. This guidance recommends the following:

- In residential settings, a daytime/evening $L_{Ae}$
- $_{q\ 16\ h}$ level of 50 dB is an indicator of moderate annoyance.
- A night-time $L_{Aeq\ 8\ h}$ level of 45 dB is recommended to prevent sleep disturbance.
- With respect to short term impulsive sources, the WHO recommends a night-time $L_{Amax}$ limit of 60 dB outside bedroom windows during night-time hours.

Impacts assessed above may be reviewed in light of the WHO recommendations. The review indicates the following:

### Construction phase

- The WHO daytime 50 dB criterion is based on a 16 h interval. It is highly unlikely that construction activities will result in LAeq 16 h levels above 50 dB, given that evening works will not be undertaken.
- The only receptor where construction phase LAeq 1 h levels may exceed 50 dB is at the dwelling outside the southeast corner during concrete breaking at the existing wastewater treatment plant. This activity is unlikely to require more than one day.
- The night-time WHO LAeq 8 h and LAmax criteria are unlikely to be exceeded at any receptor during the construction phase, as night-time construction works are not envisaged.

### Operation phase

- Following completion and occupation of the development, daytime and night-time WHO criteria are not expected to be exceeded at any offsite receptor as a result of onsite emissions.
- Little or no increase in traffic noise is expected to arise on public roads as a result of the proposed development.
- The increase in local traffic through Cnoc Fraoigh is highly unlikely to result in an LAeq 16 h level above 50 dB.
- With respect to inward impacts, external noise levels will be considerably lower than WHO criteria. Internal noise levels will also be satisfactory.

On this basis, it is considered that there will be no adverse noise impact on the local population or on human health, with the implementation of the mitigation measures described above.

## 10.5.6 Interactions

The interaction of the various elements of the proposed development was considered and assessed in this EIAR with regards to noise and vibration. The potential for each individual element of the proposed development on its own to result in significant effects on noise receptors was considered in the impact assessment. The entire project including the interactions between all its elements was also considered and assessed for its potential to result in significant effects on noise receptors in the impact assessment presented.

All interactions between the various elements of the project were considered and assessed both individually and cumulatively within this chapter. Where necessary, mitigation was employed to ensure that no cumulative effects will arise as a result of the interaction of the various elements of the development with one another.

## 10.5.7 Cumulative In-Combination Effects

The potential cumulative noise and vibration effects of proposed development, in combination with other developments in the vicinity, including all those listed in Chapter 15 of this EIAR, were also considered as part of this assessment. where appropriate the application documentation, EIAR and NIS have been reviewed to inform the assessment. There are no large scale developments previously permitted or proposed in the immediate vicinity of the Proposed Development. Thus potential cumulative noise and vibration impacts are unlikely to arise.

### 10.5.8 Summary of effects

The construction phase is expected to last several years. Noise impacts during the construction phase will be short term and slight negative at the nearest receptors, increasing to moderate negative at adjacent dwellings during certain works. No vibration impacts are expected. Inward noise levels will be satisfactory in the context of WHO and Pro-PG criteria.

No indirect impacts or interactive effects have been identified. There are no large scale developments previously permitted or proposed in the local area. Thus potential cumulative impacts are unlikely to arise.
During the post-completion phase of the development the change noise levels associated with additional traffic is predicted to be of imperceptible impact along the existing road network. In the context of the existing noise environment, the overall contribution of induced traffic is considered to be of neutral, imperceptible and permanent impact at most receptors. Impacts at Cnoc Fraoigh dwellings will be slight to moderate negative due to through traffic.

# 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.

Effect: Consequence of an impact.

Emissions: Noise originating from source under consideration, spreading spherically, hemispherically or otherwise into surrounding environment.

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.

Immissions: Inward noise received at receptor, whether from all sources (ambient) or source under consideration (specific).

Impact: Change resulting from an action, such as implementation of a project.

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.

$L_{AFmax}$: Maximum A-weighted sound pressure level occurring during measurement interval.

$L_{day}$: The A-weighted long term average incident sound pressure level determined over all the daytime periods of a year, where the daytime period is typically 0700-1900 h.

$L_{den}$: Day-evening-night noise level. Calculated from separate $L_{day}$, $L_{evening}$ and $L_{night}$ levels using formula specified in EU Directive 2002/49/EC.

$L_{evening}$: The A-weighted long term average incident sound pressure level determined over all the evening periods of a year, where the evening period is typically 1900-2300 h.

$L_{night}$: The A-weighted long term average incident sound pressure level determined over all the night-time periods of a year, where the night-time period is typically 2300-0700 h.

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.

Residual level: Noise level remaining when specific source is absent or does not contribute to ambient.

Sound pressure: Deviation over ambient atmospheric pressure due to passing sound wave. Human ear is sound pressure detector, and thus acoustic parameters ultimately relate to sound pressure. Sound pressure level is ratio of measured sound pressure to reference value.

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.

Z-weighting: Standard weighting applied by sound level meters to represent linear scale. Denoted by suffix Z in parameters such as $L_{Zeq\,T}$, $L_{ZF90\,T}$, etc. Typically used to describe spectral band levels.