# YGC

## Barmouth Flood Protection

Noise & Vibration Impact Assessment

UK.19366481 – August 2023

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# Document Control Sheet

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# 1 Introduction

1.1 Bureau Veritas was instructed by YGC to undertake a noise and vibration impact assessment for construction of the proposed flood protection improvements at Viaduct Gardens, Barmouth, Gwynedd.

1.2 The proposed works on wall in sequence include:

a) Access to the wall at beach level;
b) Temporary works;
c) Existing wall demolition / Removal;
d) Wall foundations;
e) Precast Wall;
f) Cast in situ sections;
g) In situ parapet wall; and
h) Rock Armour

1.3 The proposed pipe outfall works in sequence include:

a) Temporary works;
b) Pipe work installation;
c) Concrete surround; and
d) Outfall detail.

1.4 The main wall construction is not a piled design. The piles may only be used for the temporary works when building the new wall. It will be up to the contractor to determine whether piles are used in the temporary work, it would be a very short duration and could be phased subject to noise constraints.

1.5 The working hours of the construction will be:

- Mondays to Fridays: 0800-1800
- Saturdays: 0800-13:00; and
- and Sundays: no working

1.6 The works will be on a 12-month construction window, and they are to be phased to avoid the main school holidays and bank holidays, including Christmas, Easter, Summer Holidays, and all bank holidays.

1.7 Drainage work in the road will need to be largely complete before the works for the gardens and outfall. There maybe a little overlap in phases, but in reality, the small construction area means phases will be well defined.

1.8 It is understood that the majority of the works will be carried out using plant machinery including tracked excavators and tracked/wheeled dumpers. Sheet pilling is scheduled as part of the temporary works only if it will be used.

1.9 The nearest sensitive receptors (residential properties) are located no more than 10 m from the proposed works along the northern site boundary. A church is located approximately 19 m to the northwest of the new sea wall. Additional residential properties are located further from the site, at approximately 30 m from the works. The locations of the site boundary and the nearest sensitive receptors (NSRs) are shown in **Appendix One**.

1.10 Besides the residential receptors, Meirionnydd Oakwoods and Bat Sites SAC and Pen Ilyn a'r Sarnau SAC are identified as noise sensitive receptors.

1.11 The noise and vibration assessment has been undertaken to predict the potential impacts caused by the proposed construction activities, which may result in the worst impacts, and outline recommendations for mitigation, if required.

1.12 There will not be a permanent change in noise levels as a result of this development, therefore operational noise impact is scoped out of the assessment.

1.13 A glossary of acoustic terminology is included in **Appendix Two**.

# 2 Assessment Methods

2.1 An estimate of noise levels resulting during piling operations has been predicted using the methods described in BS 5228:2009+A1:2014 'Noise and Vibration Control on Construction and Open Sites'. This is based on proposed techniques, plant, and site operating hours.

2.2 A detailed noise propagation model was developed using CadnaA software (with built-in BS5228-1 algorithms) to predict noise contours.

2.3 The vibration datasheet provided for similar piling plant (see **Appendix Four**) provides a reasonable generic profile of vibration propagation, using the calculation methods presented in Appendix E of BS5228-2. It is not possible to accurately predict vibration propagation given the significant variables in terms of different substrata and their boundaries. Therefore, the assessment and commentary was undertaken in relation to threshold criteria published in BS5228-2 and other relevant guidance, including:

- CIRIA Technical Note 142 'Ground-borne vibration from piling'; and
- British Steel 'Control of Vibration and Noise During Piling'

### British Standard BS5228-1: 2009+A1:2014 Code of practice for noise and vibration control on construction and open sites - Part 1: Noise

2.4 Noise emissions from the construction of a proposed development are assessed differently to noise from permanent installations as it is recognised that the former is an inevitable by-product of required works and their effects are temporary. Construction activities are controlled by guidelines and subject to Local Authority control. BS5228-1 contains a database of noise emissions from individual items of equipment and activities for use in predicting the noise from demolition and construction methods at sensitive receptors. Guidance is given on the effects of different ground type, barrier attenuation and how to assess the impact of fixed and/or mobile plant.

2.5 Whilst not mandatory, Annex E of BS5228-1 provides advice to assist the development of noise assessment criteria based on previous published guidance and methodologies adopted successfully for other planning applications.

2.6 In assessing the requirement for noise limits, or operating period, controls relating to construction, Government Agencies and Local Authorities generally give consideration to the following aspects of planned works, all of which have a bearing on the 'significance' of the impact:

- The duration of the planned construction activities (weeks, months, years);

- Whether some construction works are planned for the night-time and/or weekend periods;
- The proximity of construction works relative to residential areas; and
- The predicted noise levels and noise impact at residential areas.

2.7 The above factors mean that when setting noise limits for construction works it is important to consider what noise levels are achievable and compare these with appropriate criteria to assess the impact; and where impacts are assessed as unacceptable to implement mitigation, and then re-assess the impacts against the same criteria after mitigation. It is also important to consider that measures to reduce the exposure duration over a given day is likely to result in a longer overall exposure duration in terms of completing the entire project works.

2.8 BS5228 details the "ABC Method for construction noise assessment", which is shown in **Table 2.1**.

**Table 2.1: Construction Noise Impact Assessment Criteria Assessment**

| Assessment category and threshold value period | Threshold value, $L_{Aeq}$ (dB) | | |
|---|---|---|---|
| | Category A | Category B | Category C |
| Night-time | 45 | 50 | 55 |
| Evenings and weekends | 55 | 60 | 65 |
| Daytime and Saturdays | 65 | 70 | 75 |

- Night-time is considered between 23:00 and 07:00. Evenings and weekends are considered to be 19:00 – 23:00 on weekdays, 13:00 – 23:00 on Saturdays and 07:00 – 23:00 on Sundays. Daytime is considered to be 07:00 – 19:00 on weekdays and Saturdays 07:00 – 13:00.
- The NSR is defined as Category A if the ambient noise levels (rounded to the nearest 5 dB) are less than those stated for category A.
- The NSR is defined as Category B if the ambient noise levels (rounded to the nearest 5 dB) are equal to those stated for category A.
- The NSR is defined as Category C if the ambient noise levels (rounded to the nearest 5 dB) are greater than those stated for category A.

2.9 For the purpose of this assessment, noise levels are assessed with reference to the 5 dB(A) Change method presented in Annex E of BS 5228-1. Subject to lower cut-off values of 65 dB, 55 dB and 45 dB $L_{Aeq,T}$ from site noise alone, for the daytime, evening and night-time periods, respectively, any increase over 5 dB is deemed as medium or high magnitude of change (depending on the excess), while under 5 dB change is deemed to be a low or negligible magnitude of change (depending on the margin).

### BS5228-2:2009+A1:2014 - Noise and Vibration Control on Construction and Open Sites – Part 2: Vibration

2.10 BS5228-2 describes methods of mitigation that can be employed for ground-borne vibration from construction activities and provides historical library data of vibration levels measured during various activities on various ground types.

2.11 **Table 2.2** (Table B.1 from BS5228-2) describes the likely response to various peak particle velocity (PPV) vibration levels.

**Table 2.2: Typical Human Responses to Different PPV Levels**

| Vibration Level (mm/s) | Effect | Impact |
|---|---|---|
| 0.14 | Vibration might just be perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration. | Negligible |
| 0.3 | Vibration might just be perceptible in residential environments. | Minor |
| 1.0 | 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. | Moderate |
| 10 | Vibration is likely to be intolerable for any more than a very brief exposure to this level. | Major |

### British Steel 'Control of Vibration and Noise During Piling'

2.12 This document specifies vibration and noise level estimation and measurement during piling. At ground surface, and within some 2-30 m of the pile, they are easily observed by vibration transducers, and also by personal sensation. Surface vibrations comprise three components in the vertical and two horizontal directions (outward radial and tangential/transverse), but it is usually adequate to consider only the largest component which is often in the vertical direction.

2.13 The guidance shows different forms of vibration observed at ground surface caused by an impact hammer and a vibrodriver. The strong signal caused by an impact hammer only lasts some 0.1 second, and so is a very transient event. The vertical component is the largest, commonly with the largest value as peak particle velocity (PPV) in units of 30mm/s. The ground surface vibrations of a vibrodriver are similar to pure sine waves, having a frequency locked on to the vibrodriver operating frequency, about 28 Hz. The peak particle velocity of the largest, radial wave is 22 mm/s.

2.14 The guidance introduced a simple empirical equation for prediction of probable levels of ppv due to various piling operations and conditions, and for probable upper bound levels. The equations generally take the form of:

$$v = \frac{C\sqrt{W}}{r}$$

Where v is the estimated PPV in mm/s

C is a parameter related to soil Type and hammer

W is the hammer energy per blow or per cycle (Joule/blow, or J/cycle for vibrodrivers)

r is the horizontal distance from the piling operation to the point of interest (m)

2.15 The recommendations in the draft Eurocode EC3 give C values as in **Table 2.3**.

**Table 2.3: C values in different ground conditions**

| Driving Method | Ground Conditions | C |
|---|---|---|
| Impact | Very stiff cohesive soils, dense granular media, rock, fill with large solid obstructions | 1.0 |
| | Stiff cohesive soils, medium dense granular media, compact fill | 0.75 |
| | Soft cohesive soils, loose granular media, loose fill, organic soils | 0.5 |
| Vibratory | All soil conditions | 0.7 |

2.16 The noise levels experienced in the vicinity of pile driving are a function of the noise power level, $L_W$, which is the air pressure fluctuation at the surface of the equipment (hammer or pile), expressed in dB, and the distance, R, from the source. A convenient method to estimate an equivalent continuous A-weighted sound level over the working day, $L_{Aeq}$, is by the equation:

$$L_{Aeq} = L_W - 20\log(R) - 8\,dBA$$

2.17 For impact hammer acting on steel sheet or H section piles, these typically range from 120 – 135 dB.

### CIRIA Technical Note 142 ‘Ground-borne vibration from piling’

2.18 This guidance is an introduction to the nature and effects of ground borne vibrations caused by piling and similar works. It contains guidance about the nature of these vibrations and about how they are propagated.

2.19 It also gives the threshold of human perception of vibration. Expressed in terms of peak particle velocity the threshold of perception corresponds to a velocity of about 0.15 to 0.3 mm/s at frequencies between 8 and 80 Hz. As their intensity increase, vibrations become irritating, annoying and can even be frightening at intense levels.

### British Standard 8233: 2014 Guidance on Sound Insulation and Noise Reduction for Buildings

2.20 BS 8233:2014 provides guidance for the control of noise in and around buildings. It is applicable to the design of new buildings, or refurbished buildings undergoing a change of use.

2.21 With regards to external sound sources affecting habitable residential spaces, Table 4 of BS 8233:2014 provides guideline values that it is desirable to not exceed during daytime and night time periods. These guideline values are reproduced in **Table 2.4**.

**Table 2.4: Indoor ambient sound levels for dwellings**

| Activity | Location | 07:00 to 23:00 | 23:00 to 07:00 |
|---|---|---|---|
| Resting | Living Room | 35 dB $L_{Aeq,16hour}$ | - |
| Dining | Dining room/area | 40 dB $L_{Aeq,16hour}$ | - |
| Sleeping (daytime resting) | Bedroom | 35 dB $L_{Aeq,16hour}$ | 30 dB $L_{Aeq,8hour}$ |

2.22 For traditional external areas that are used for amenity space, such as gardens and patios, BS8233 states that it is desirable that the external sound 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.

2.23 ISO 9613-2:1996 'Acoustics - Attenuation of Sound during Propagation Outdoors - Part 2: General Method of Calculation'

2.24 ISO 9613-2:1996 specifies methods for the description of sound outdoors in community environments. ISO 9613 can be applied to a wide variety of sound sources and includes methods to determine most of the major mechanisms of sound attenuation, such as:

- Geometric divergence ($A_{div}$) - spherical spreading of sound energy;
- Atmospheric absorption ($A_{atm}$) - attenuation of sound due to interaction with the air (dependant on frequency of sound and negligible at short distances);
- Ground effect ($A_{gr}$) - sound reflecting by the ground surface interfacing with the sound propagating directly from source to receiver;
- Reflection from surfaces (image source method, included in $A_{gr}$ calculation) - sound is reflected from hard surfaces such as building facades due to atmospheric impedance of the surface. This effect increases the sound level when compared to a location free of buildings (i.e. free field); and
- Screening by obstacles ($A_{bar}$) - Hard obstacles such as close boarded timber fences and varying topography, including hills attenuate the sound from a source due to the insertion loss properties of the obstacle. However, there is an element of the sound which will diffract around the obstacle, especially at lover frequencies. The diffraction effect is determined using the path differences between the direct and diffracted sound. It should be noted that the screening effect provided by trees and foliage is negligible in the majority of cases; the exception is large areas of dense forest or plantations.

# 3 Baseline Conditions

3.1 Attended daytime ambient and background sound level measurements were conducted at representative locations to indicate the sound climate at the nearest noise sensitive receptors on 29th June 2023.

3.2 The noise monitoring equipment was calibrated before and after the measurement surveys using an acoustic calibrator, which had itself been calibrated against a reference set traceable to National and International Standards. It is considered that no unusual events occurred during the survey periods and the measurement data are considered to be a true and a fair representation of the ambient noise levels. No drift in calibration level was observed.

3.3 The sound level meter was set to record in 15-minute interval values for the measurement period, for the $L_{A90}$, $L_{Aeq}$ and $L_{Amax}$ indices. The details of the equipment used for the site survey can be found in Appendix Three. The measurement location is shown in Appendix One.

3.4 Noise measurements were made at two locations (see Appendix One) in a free-field condition with the sound level meter mounted ~1.5m above local ground level. The weather over the survey period was dry with 1/8 octets cloud, no rain and a light breeze (2-3 m/s) from the NW. The temperature was 21°C. A protective windshield was also fitted to the microphone.

3.5 The results from the ambient sound level survey are detailed in Table 3.1 below.

**Table 3.1: Ambient and Background Sound Level Measurements**

| Location | Date | Start Time | $L_{Aeq,15min}$ (dB) | $L_{A90,15min}$ (dB) | $L_{AFmax,15min}$ (dB) |
|---|---|---|---|---|---|
| ST1 | 29/06/22 | 11:48 | 60 | 44 | 79 |

3.6 The noise climate at both locations was dominated by road traffic on A496 Porkington Terrace. Other contributory noise sources comprised herring gulls, dogs barking, as ingle 4-carriage passenger train passing by, and pedestrians. Noise from a kitchen extract unit on west façade of 'The Last Inn' pub/restaurant was dominant at the western half of Viaduct Gardens between traffic movements.

3.7 The sound level **60 dB** $L_{Aeq,15min}$ is considered to be representative of the typical ambient sound level at the NSRs during daytime.

3.8 As stated above, the construction work will only occur on weekdays. Based on the threshold criteria presented in **Table 2.1**, the construction noise thresholds that have been adopted for the development to indicate the potential noise impacts are presented in **Table 3.1** (Daytime).

**Table 3.1: Weekday Daytime (0800-1800) Construction Noise Thresholds**

| Receptor | Ambient Noise Level dB $L_{Aeq}$ | BS5228-1 ABC Category | Construction Noise Threshold, dB $L_{Aeq}$ |
|---|---|---|---|
| NSR1 | 60 | A | 65 |
| NSR2 | 60 | A | 65 |
| NSR3 | 60 | A | 65 |

# 4 Construction Noise Assessment

4.1 An estimate of noise levels resulting from the construction was predicted using the methods described in the guidance. The sound levels of construction noise at the nearest sensitive receptors are predicted by noise modelling, using CadnaA.

4.2 Noise propagation was predicted using algorithms described in ISO 9613-2, as incorporated within the noise modelling software, which considered geometric spreading, topography, screening, ideal meteorological conditions and detailed information regarding the sources of noise.

4.3 The following assumptions were used in the model:

- All sound propagation assumes 10°C and 70% relative humidity.
- A ground absorption value of 0.5 was used for areas mixed with buildings and green areas, 0.7 was used for vegetation areas and 0 for water areas.
- The sheet piling noise was modelled as a point sound source.

4.4 At this stage, the details of construction plant items for each phase have not been confirmed yet. However, as mentioned in Section 1, the significant sound sources will be tracked excavators and tracked/wheeled dumpers. The sound level and spectrum of the sound sources was set up based on the data for similar plants (see **Appendix Four**). It is assumed there would be two tracked excavators and two tracked/wheeled dumpers working simultaneously on site.

4.5 The values are determined, assuming that all the activity is located at the closest approach to the receptors without any noise barriers, and therefore represent the typical worst-case scenario. Development noise levels would be expected to reduce as works move further from the receptors. The noise contours of the construction works are shown in **Appendix Five**.

4.6 The predicted highest noise levels from sheet pile installation at noise sensitive receptors are presented in Table 4.1.

**Table 4.1: Predicted Daytime Construction Noise Levels**

| Receptor | Predicted Peak Activity Noise Level, dB $L_{Aeq,T}$ | Weekday Daytime (0800-1800) Threshold, dB $L_{Aeq,T}$ | Variation, dB |
|---|---|---|---|
| NSR1 | 67 | 65 | +2 |
| NSR2 | 67 | 65 | +2 |
| NSR3 | 63 | 65 | -2 |

4.7 The results in Table 4.1 indicate that daytime construction noise levels will be of negligible magnitude of change at NSR3 and low magnitude of change at NSR1 and NSR2.

4.8 No evening and night-time construction work is proposed.

4.9 In conclusion, low construction noise impacts are predicted for NSRs at daytime. Specific noise mitigation will be required, and standard best practice is discussed in Section 7.

4.10 In addition, in the worst case, the construction noise at the Meirionnydd Oakwoods and Bat Sites SAC is predicted to be lower than 40 dB $L_{Aeq}$, and noise levels at the majority of the Pen llyn a'r Sarnau SAC are predicted between 55 to 60 dB $L_{Aeq}$.

4.11 In the IECS report 'Construction and waterfowl: Defining sensitivity, response, impacts and guidance' by Cutts *et al.*[1], some guidance is provided on noise levels which instigate responses from shorebirds.

4.12 In relation to construction noise, the following observations of flight responses or behavioural changes were noted:

- Irregular piling noise (above 70 dB): High to Moderate
- Irregular noise (50-70 dB): Moderate
- Regular noise (50-70 dB): Moderate to Low
- Noise below 50 dB: Low

4.13 The construction noise impact is assessed as Low to Moderate. The noisiest construction activities should avoid the majority of the breeding period and displacing settling birds.

[1] 'Construction and waterfowl: Defining sensitivity, response, impacts and guidance', Cutts et al, Institute of Estuarine and Coastal Studies, Feb 2009

# 5 Short-period Sheet Piling Noise Assessment

5.1 An estimate of noise levels resulting from the sheet pile installation was predicted using the methods described in the guidance. The sound levels of sheet piling noise at the nearest sensitive receptors are predicted by noise modelling, using CadnaA.

5.2 Noise propagation was predicted using algorithms described in ISO 9613-2, as incorporated within the noise modelling software, which considered geometric spreading, topography, screening, ideal meteorological conditions and detailed information regarding the sources of noise. The same assumptions were used as construction noise assessment above.

5.3 The sound level and spectrum of the sound source was set up based on the data for similar piling plant (see **Appendix Six**). The height of sound source was set as 6 m high and % operation time as 10% over the ten daytime working hours.

5.4 The values are determined, assuming that all the activity is located at the closest approach to the receptors without any noise barriers, and therefore represent the typical worst-case scenario. Development noise levels would be expected to reduce as works move further from the receptors. The noise contours of the piling activities are shown in **Appendix Seven**.

5.5 The predicted highest noise levels from sheet pile installation at noise sensitive receptors are presented in **Table 5.1**.

**Table 5.1: Predicted Daytime Sheet Piling Noise Levels**

| Receptor | Predicted Peak Activity Noise Level, dB $L_{Aeq,T}$ | Weekday Daytime (0800-1800) Threshold, dB $L_{Aeq,T}$ | Variation, dB |
|---|---|---|---|
| NSR1 | 74 | 65 | +9 |
| NSR2 | 74 | 65 | +9 |
| NSR3 | 70 | 65 | +5 |

5.6 At NSR1, sheet piling noise level is above the Weekday Daytime Threshold by 9 dB, which is assessed as high magnitude of change.

5.7 At NSR2, sheet piling noise level is above the Weekday Daytime Threshold by 9 dB, which is assessed as high magnitude of change.

5.8 At NSR3, sheet piling noise level is above the Weekday Daytime and Saturdays Threshold by 5 dB, which is assessed as medium magnitude of change.

5.9 The piling noise source is mobile, so the noise received at any control points will vary from day to day as work proceeds. It is noted that the results in **Table 5.1** are the worst cases, assuming closest possible approach.

5.10 It is understood that it has not been determined if piles are used in the temporary work. If the piles are used, the noise levels at the NSRs are significantly higher than the ambient noise. Therefore, the sheet piling noise will result in significant adverse impacts on the NSRs, although total duration of piling operations may be short and the noisiest part of the piling process will occur at each individual pile location only for a short period of time.

5.11 Noise mitigation measures and best practice will be needed to minimise the adverse impacts.

# 6 Short-term Sheet Piling Vibration Assessment

6.1 Ground borne and airborne vibration should be considered in relation to piling activities. Due to the complex relationship between the source of vibration, forcing frequency, the distance and geological characteristics between source and receiver and the construction of the receiving structure, it is very difficult to predict the degree of vibration which may occur.

6.2 However, the level of vibration required to cause structural damage is very high and unlikely to be reached in the construction of the Development. Piling activities can produce perceptible levels of vibration, although mitigation measures can be employed to reduce the effect. Adverse effects of vibration would be expected only within approximately 10 m of such works.

6.3 **Table 6.1** presents the vibration levels from vibratory sheet pile installation were predicted based on the shortest distance between the NSRs and the piling locations.

**Table 6.1: Predicted Vibration Caused by Piling**

| Receptor | Distance between the NSRs and nearest piling locations (m) | Estimated Vibratory Vibration Level PPV in mm/s |
|---|---|---|
| NSR1 | 20 | 3.7 |
| NSR2 | 22 | 3.4 |
| NSR3 | 30 | 2.5 |

6.4 It can be seen in **Table 6.1** that the PPVs of vibratory piling at NSRs are above 1 mm/s, and 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, according to **Table 2.2**. The vibration impact of vibratory piling is assessed as Moderate.

6.5 The total duration of piling operations will also be limited to daytime only, and the maximum level of vibration (**Table 6.1**) would only occur for a very short period whilst the works are at the closest approach. Good communication with local residents in accordance with best practice, including provision of an estimated schedule of works, should be sufficient to allay any concerns.

6.6 Airborne vibration typically can be effectively controlled via best practice mitigation measures employed to reduce the effect of airborne noise.

6.7 Therefore, construction vibration activities at the nearest receptors are predicted as Minor, which is acceptable.

# 7 Mitigation Measures

7.1 As it is stated in BS5228-1, special precautions should be taken to mitigate the disturbance created during construction activities, particularly in noise-sensitive areas.

7.2 In this case, it is not possible to reduce the noise impacts by increasing the distance between the source and receiver. The following mitigation measures are suggested:

- Noise barriers should be installed along northern site boundary for construction works near NSR1 that are shown to experience adverse effect from construction noise. A reduction in construction noise of up to 10 dB should be achieved;
- The contractor would produce and implement a Noise Management Plan for the construction phase. The plan will be taken forward by the applicant for any post construction works of a similar nature that are associated with the proposed development e.g., maintenance. The plan will be agreed with the consenting authority.

7.3 Screening of the dominant noise source (vibratory hammer) is not practicable as this will be located up to more than 10 m above ground level, therefore, the usage of sheet piling should be avoided if possible.

7.4 Finally, good public relations and communication are essential. Local residents might be willing to accept higher levels of noise if they know that such levels will only last for a short time. It is then important that construction activities are carried out in accordance with the stated schedule and that the community is informed of their likely durations, and any unforeseen changes to the schedule.

7.5 A communication will be issued to all affected local residents providing a point of contact for noise and/or vibration queries or complaints, and a suitable response procedure to be implemented by the Contractor.

# 8 Conclusions

8.1 An estimate of noise and vibration impacts resulting from the construction works has been predicted using the methods described in BS 5228: 'Noise and Vibration Control on Construction and Open Sites'.

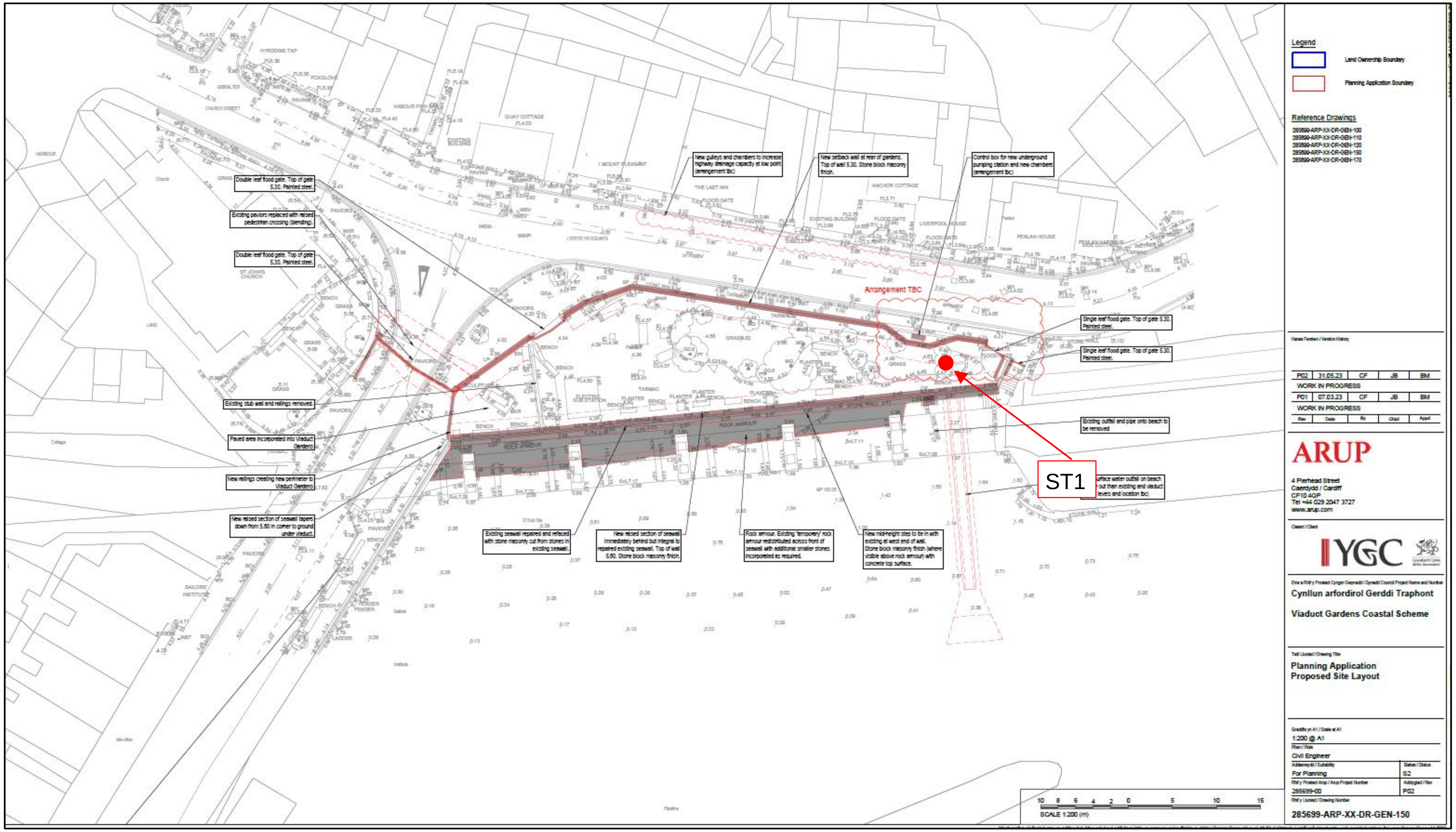
8.2 A computational noise model of the proposed development was assembled and populated with the noise emission data of each phase. Standard noise propagation calculations were used to predict the noise levels at the nearest noise sensitive receptors.

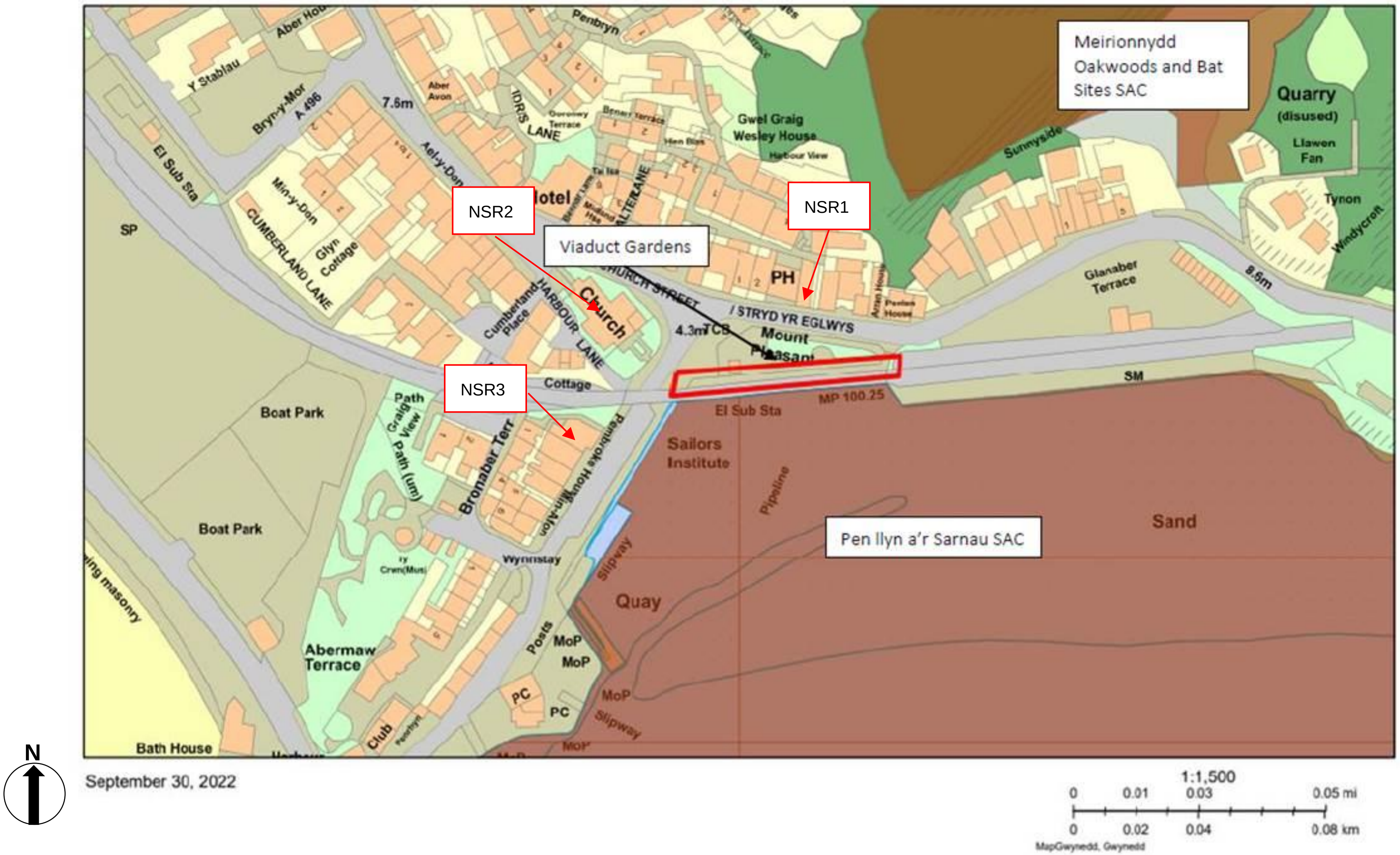
8.3 The assessment concludes that the impacts of the construction noise on the nearest residential receptors can be acceptable with suggested noise mitigation measures and best practice.

8.4 Regarding sheet piling, its vibration is assessed as minor and thus no further mitigation measures are required, however, sheet piling noise will have potentially significant adverse impacts on the nearest sensitive receptors, which should be avoided if possible.

8.5 The noise impacts of construction noise can be assessed as Low with the suggested mitigation measures.

# Appendix One – Plan Layout




Meirionnydd Oakwoods and Bat Sites SAC
NSR1
NSR2
NSR3
Viaduct Gardens
Pen llyn a'r Sarnau SAC
Quarry (disused)
Sand
Quay
Boat Park
Boat Park
Sailors Institute
El Sub Sta
MP 100.25
SM
Church
Mount Pleasant
CHURCH STREET / STRYD YR EGLWYS
PH
Glanaber Terrace
Bronaber Terr
Abermaw Terrace
Bath House
September 30, 2022
1:1,500
0 0.01 0.03 0.05 mi
0 0.02 0.04 0.08 km
MapGwynedd, Gwynedd

# Appendix Two – Glossary of Acoustic Terminology

| | |
|---|---|
| **Sound power level** | A logarithmic measure of the power of a sound relative to a reference value. |
| **"A" Weighting (dB(A))** | The human ear does not respond uniformly to different frequencies. "A" weighting is commonly used to simulate the frequency response of the ear. It is used in the assessment of the risk of damage to hearing due to noise. |
| **Decibel (dB)** | The range of audible sound pressures is approximately 2 x $10^{-5}$ Pa to 200 Pa. Using decibel notation presents this range in a more manageable form, 0 dB to 140 dB. |
| **Ambient sound level, $L_{Aeq,T}$** | equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation at a given time, usually from many sources near and far, at the assessment location over a given time interval, T.<br>NOTE The ambient sound level is a measure of the residual sound and the specific sound when present. |
| **Background sound level, $L_{90,T}$** | A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels. |
| **Maximum sound level, $L_{Amax,T}$** | The maximum RMS A-weighted sound pressure level occurring within a specified time period. |
| **Noise** | Unwanted sound. |
| **Ambient sound** | Totally encompassing sound in a given situation at any given time composed of noise from many sources, near and far. |
| **Residual sound** | Ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound. |
| **Rating level** | Specific sound level plus any adjustment for the characteristic features of the sound. |

# Appendix Three – Monitoring Equipment

## Noise Equipment

| | |
|---|---|
| Rion NL-52 Sound Analyser | Serial Number 00253699 |
| Rion UC-59 Microphone | Serial Number 07493 |
| Brüel and Kjær Sound Level Calibrator Type 4231 | Serial Number 1882323 |

# Appendix Four – Plant Noise Data

| Plant Item | BS5228-1 Reference | Sound Pressure Level at 10m, dB $L_{Aeq}$ | Sound Power Level, dB $L_{Aeq}$ | Number in Use | On-Time % |
|---|---|---|---|---|---|
| Tracked excavator | C.2/3 | 78 | 106 | 2 | 20 |
| Dumper | C.4/3 | 76 | 104 | 2 | 20 |
| Sheet piling | - | - | 120 | 1 | 10 |

# Appendix Five – Noise Contours of Construction Activities

**Figure A5.1: Indicative prediction of construction noise contours during daytime – 1.5 m above ground – Near NSR1**

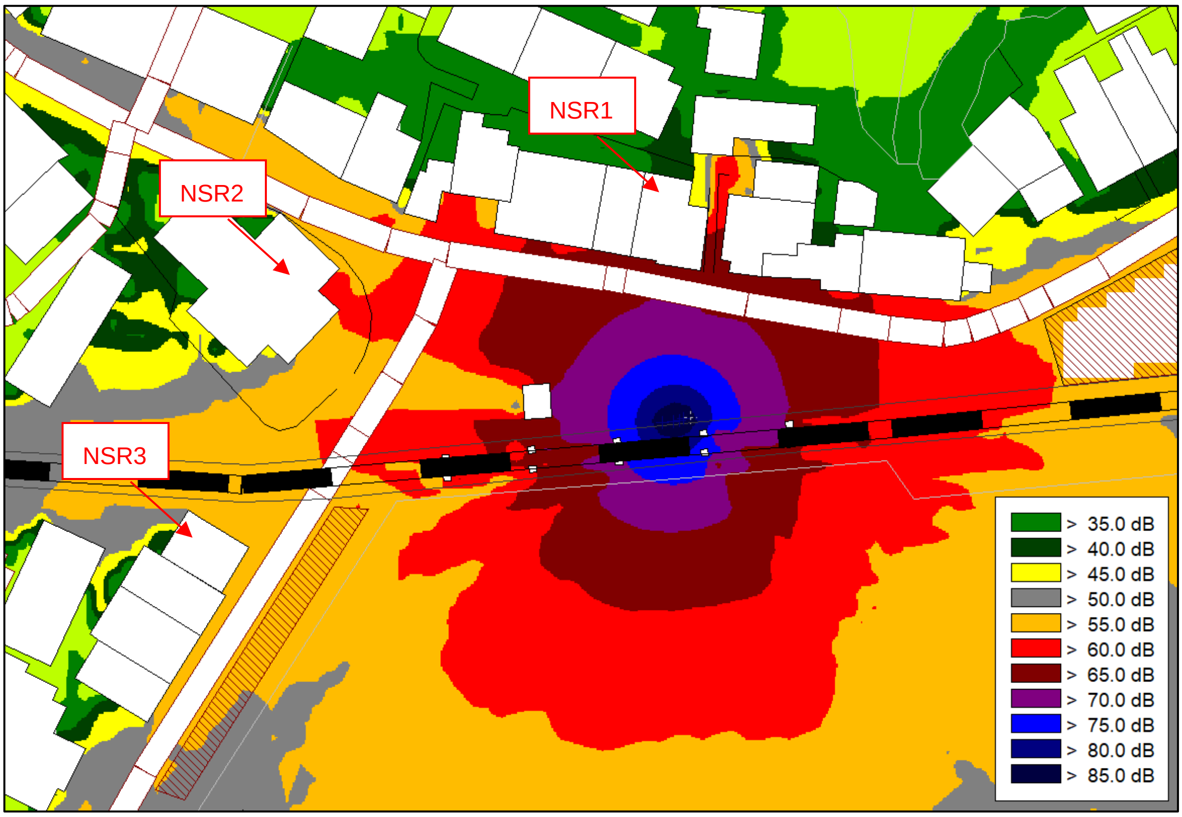
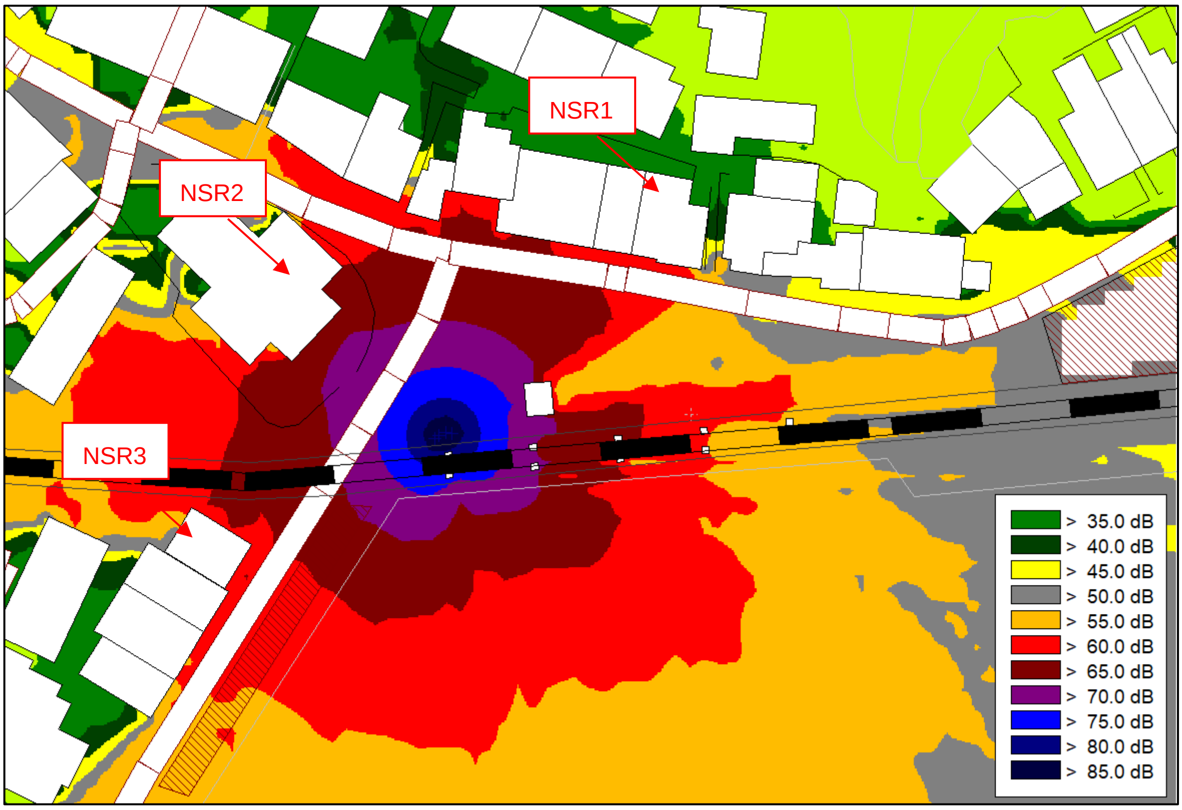


**Figure A5.2: Indicative prediction of construction noise contours during daytime– 1.5 m above ground – Near NSR2 and NSR3**



# Appendix Six - Noise and Vibration Data from Fisher Piling

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PILING SERVICES LTD

*Nationwide design, supply, install & extract of all aspects of steel / sheet piling and associated framing / welding*

**Guidance on typical Noise Levels arising from Steel Pile Installation using Vibratory Leader Rig**

Note: Noise levels during sheet pile installation are dependent on a variety of factors including, but not limited to:

- sheet pile length
- sheet pile section
- ground conditions
- plant type
- method of working

The noise data as detailed below should only be used to provide an indication of the noise levels. Actual noise level monitoring should be undertaken at receptor points to allow correct protection / mitigation measures to be formulated / implemented.

**Noise survey for Leader Rig**

A Casella Cel490 sound level meter was used to carry out noise assessments in the working area for the purpose of setting up noise hearing zones and choosing the correct type of hearing protection:

| Location of Meter | Duration of Survey | $L_{C,peak}$ | $L_{EQ}$ | $L_{EP,d}$ | No. of workers exposed |
|---|---|---|---|---|---|
| Approximately 1m away from the noise source | 5 min | 120 | 110 | 111 | 2 |

| Frequency Analysis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Frequency (Hz)** | **63** | **125** | **250** | **500** | **1000** | **2000** | **4000** | **8000** |
| Reading dB (Z) | **82.2** | **90.7** | **92.2** | **102.6** | **106.5** | **105.2** | **97** | **86.6** |
| A-weighting | -26 | -16 | -9 | -3 | 0 | 1 | 1 | -1 |
| Noise levels dB (A) | 56.2 | 74.7 | 83.2 | 99.6 | 106.5 | 104.2 | 96 | 85.6 |
| Mean Attenuation of defender | 30.0 | 33.1 | 36.3 | 38.4 | 38.7 | 39.7 | 48.3 | 44.4 |
| Standard deviation of defender | 3.9 | 5.0 | 7.4 | 6.2 | 5.6 | 4.3 | 4.5 | 4.4 |
| Assumed Protection dB | 26.1 | 28.1 | 28.9 | 32.2 | 33.1 | 35.4 | 43.8 | 40.0 |
| Noise Level at Operators Ear | 30.1 | 46.6 | 54.3 | 67.4 | 73.4 | 68.8 | 52.2 | 45.6 |

| Additional Information | | | |
|---|---|---|---|
| Background Noise Level | N/A | Type of Meter | Casella Cel 490 |

**Conclusion**

A mandatory "Hearing protection zone" should be in place at a radius of 17 meters, from the working elevations when no segregation walls are in place.

Expected noise levels at various distances:

- 5m distance – 96 dB
- 7m distance – 93 dB
- 10m distance – 90 dB
- 15m distance – 86 dB
- 20m distance – 84 dB

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| | |
|---|---|
| Project: | Hirael FAS - ECI |
| Subject: | Sheet Pile Installation - vibratory methods only |

| Prepared: PJF | Date: 06.12.21. | Ref: C1357 / PJF / 005 | Page: 1 |
|---|---|---|---|

| Equipment | Type | Energy - W |
|---|---|---|
| MRZV 20V (TM14/17) | Vibratory | 11236 |

**Distance to Subject - r**

10 m

**Vibration Equation**

$v = C\sqrt{W}/r$

where; $v$ = peak particle velocity, mm/s
$C$ = Soil / Hammer co-efficient
$W$ = Energy, J per cycle
r = distance to subject

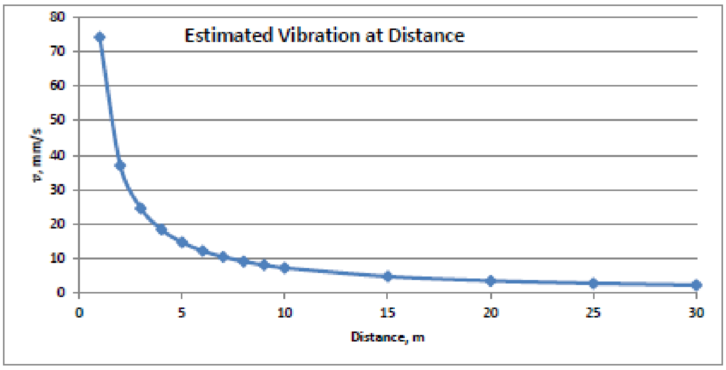
**Coefficient Table**

| Method | Ground Conditions | C |
|---|---|---|
| Impact | Very stiff cohesive, dense granular, rock, fill with large obstructions. | 1 |
| | Stiff cohesive, medium dense granular, compact fill. | 0.75 |
| | Soft cohesive, loose granular, loose fill, organic soils. | 0.5 |
| Vibro | All Soils | 0.7 |

C Value Adopted = 0.7

**Vibration Estimates**

| Distance, m | $v$, mm/s |
|---|---|
| 1 | 74.2 |
| 2 | 37.1 |
| 3 | 24.7 |
| 4 | 18.5 |
| 5 | 14.8 |
| 6 | 12.4 |
| 7 | 10.6 |
| 8 | 9.3 |
| 9 | 8.2 |
| 10 | 7.4 |
| 15 | 4.9 |
| 20 | 3.7 |
| 25 | 3.0 |
| 30 | 2.5 |
| At Subject | 7.4 |




**Typical Tolerance of buildings (not occupants)**

| | $v$, mm/s | Acceptable Distance, m |
|---|---|---|
| Ruins, buildings of architectural merit | 2 | 37.1 |
| Residential | 5 | 14.8 |
| Light commercial | 10 | 7.4 |
| Heavy Industrial | 15 | 4.9 |
| Buried Services (general) | 25 | 3.0 |
| Buried Services (old brick sewers) | 12.5 | 5.9 |

*note: these figures are for guidance only, client should establish and advise the specific permissible level of vibration for receptors of interest*

# Appendix Seven – Noise Contours of Piling Activities

**Figure A7.3: Indicative Prediction of Sheet Piling noise contours during daytime– 1.5 m above ground – Near NSR1**

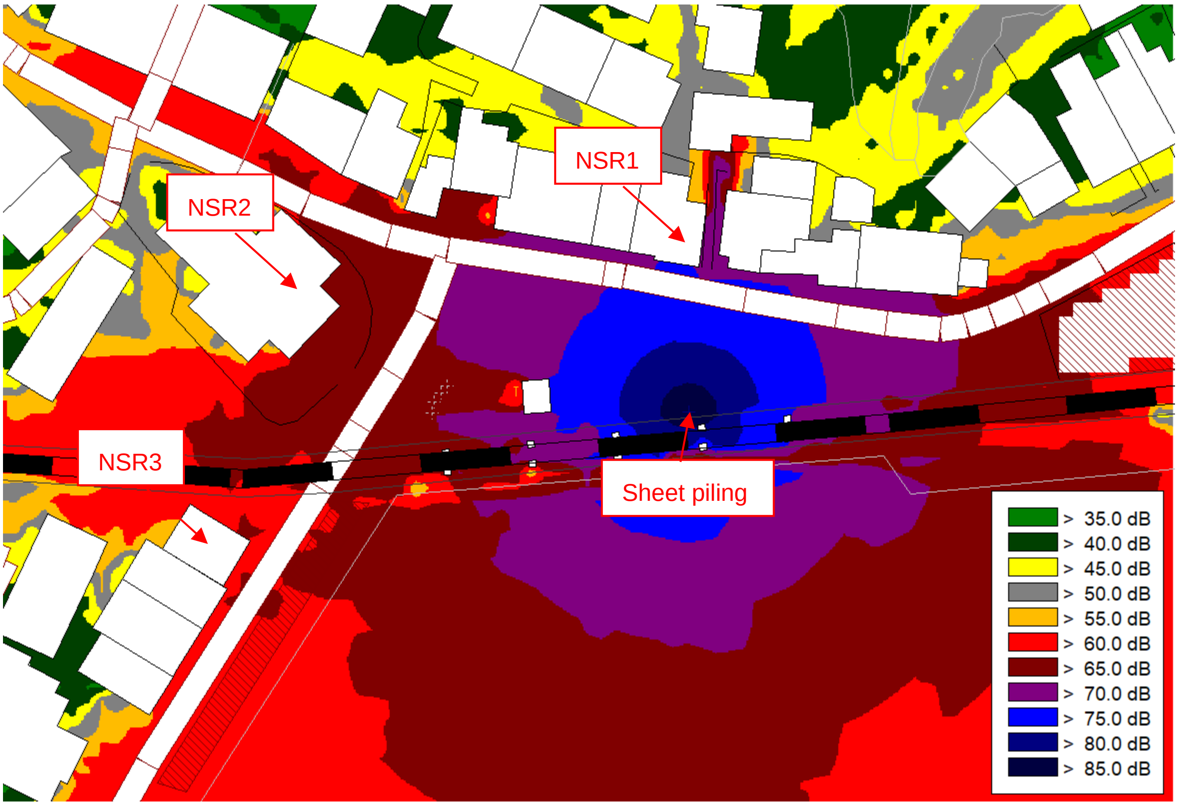


**Figure A7.4: Indicative Prediction of Sheet Piling noise contours during daytime– 1.5 m above ground – Near NSR2 and NSR3**