Technical Note:

Land West of Formby Bypass – Potential Construction Impacts

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Experts in noise and vibration assessment and management

Document Control

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Executive Summary

This report considers the potential for adverse noise and vibration impacts from piling activities at a residential development on Liverpool Road, Formby.

The report has considered the potential impacts associated with five piling methods, namely:

- Bored piling;
- Driven piling;
- Pressed-in piling;
- Vibrodisplacement piling; and
- Deep compaction piling.

During piling activities in the vicinity of the site boundary, all piling methods have the potential to exceed noise threshold criteria without appropriate mitigation. Of the methods considered, and based on the assumptions stated in this report, pressed-in piling is considered to be the most preferable on noise grounds. Driven piling is shown to be the least preferable on noise grounds.

In terms of vibration, all piling methods have the potential to result in perceivable vibration at multiple buildings, with some methods having the potential to cause cosmetic damage, such as vibrodisplacement.

With reference to the provisions set out within 'A Local Plan for Sefton' (2017) and the obligations set out within the CoPA (1974), appropriate mitigation and consideration of Best Practicable Means should be taken in to account by the contractor prior to any further proposed piling works.

1 Introduction

1.1 Noise Consultants Limited ('NCL') have been commissioned by Formby Parish Council (FPC) to consider the potential for adverse noise and vibration impacts from construction activities associated with a residential development on Liverpool Road, Formby (the 'site').

1.2 The residential development includes the erection of 304 dwellings with associated access, open space, drainage infrastructure, parking, landscaping, infrastructure and other associated works (planning application reference: DC/2018/00658).

1.3 The site is bounded to the west by existing residential properties.

1.4 Ground preparation works at the site started in 2020, and resulted in FPC receiving complaints from residents relating to excessive noise, in particular during piling activities.

Background

A Local Plan for Sefton (Adopted April 2017)

1.5 Policy EQ4 of the Local Plan for Sefton is relevant to noise and vibration, and states the following:

'1. Development proposals should demonstrate that environmental risks have been evaluated and appropriate measures have been taken to minimise the risks of adverse impacts which include amenity, damage to health and wellbeing, property and the natural environment (including internationally important nature sites) from:

a. Pollution of the land, water (including surface water and groundwater) and the air,

b. Hazardous substances,

c. Noise/vibration, dust, odour or artificial light pollution.'

2. Development will be permitted where it can be demonstrated that:

a. Appropriate measures are incorporated into proposals to avoid pollution to air, water and soil,

b. There would be no unacceptable risk to the users of the site, occupiers of neighbouring land or the environment from the presence of hazardous substances. Proposals for sensitive uses close to existing sources of pollution must demonstrate that there will be no detrimental impact on the amenity of existing or future occupiers,

c. The impact of noise/vibration and lighting will not be significant or can be reduced to an acceptable level.

3. Development must lead to no deterioration of, and where practicable improve, water quality, and must protect and enhance Sefton's waterbodies and water environment.

4. The cumulative effects of pollution will be taken into account in terms of the impact of a number of developments in an area. The effects of a combination of various types of pollution will also be considered.'

Control of Pollution Act (CoPA, 1974)

1.6 Obligations under the CoPA (1974) are that contractors apply best practicable means (BPM) during construction works at all times to minimise noise (including vibration) at neighbouring residential properties and other sensitive receptors.

1.7 BPM are defined in Section 72 of the CoPA and Section 79 of the Environmental Protection Act 1990 as those measures which are:

"reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge and to financial implications".

Scope of Works

1.8 The noise impact assessment supporting the planning application (Barratt Homes (Manchester), Liverpool Road, Formby, Noise Impact Assessment Report, June 2018) does not include specific consideration of likely noise and vibration impact during construction. The noise impact assessment report states it is *'in accordance with applicable standards and guidance, and in line with the requirements of Sefton Metropolitan Borough Council (SMBC)'*.

1.9 Policy EQ4 of the Local Plan requires proposed developments to demonstrate that noise and vibration risks have been appropriately evaluated, including those relating to construction activities. Where a risk has not been appropriately evaluated at the planning stage, reactive controls are still available to Local Authorities using mechanisms under CoPA, namely a Section 60 notice.

1.10 The development associated piling activities are currently paused, however in anticipation that further complaints will occur when they start up again, FPC have requested that the contractor provides quantitative noise and vibration information associated with development, and details of the proposed BPM.

1.11 FPC has requested SMBC to obtain this information through the requirements of a CoPA Section 60 notice.

1.12 In advance of any further information being provided by the contractor, and/ or any quantitative data obtained through a Section 60 notice, FPC has asked NCL to quantify the likely noise and vibration immissions at the existing residential properties from a variety of construction piling types.

1.13 The intention is that information would identify piling activities that are likely to result in the greatest noise and vibration immissions at the existing receptors, and inform SMBC's assessment of the proposals with respect to BPM.

2 Description of the Development

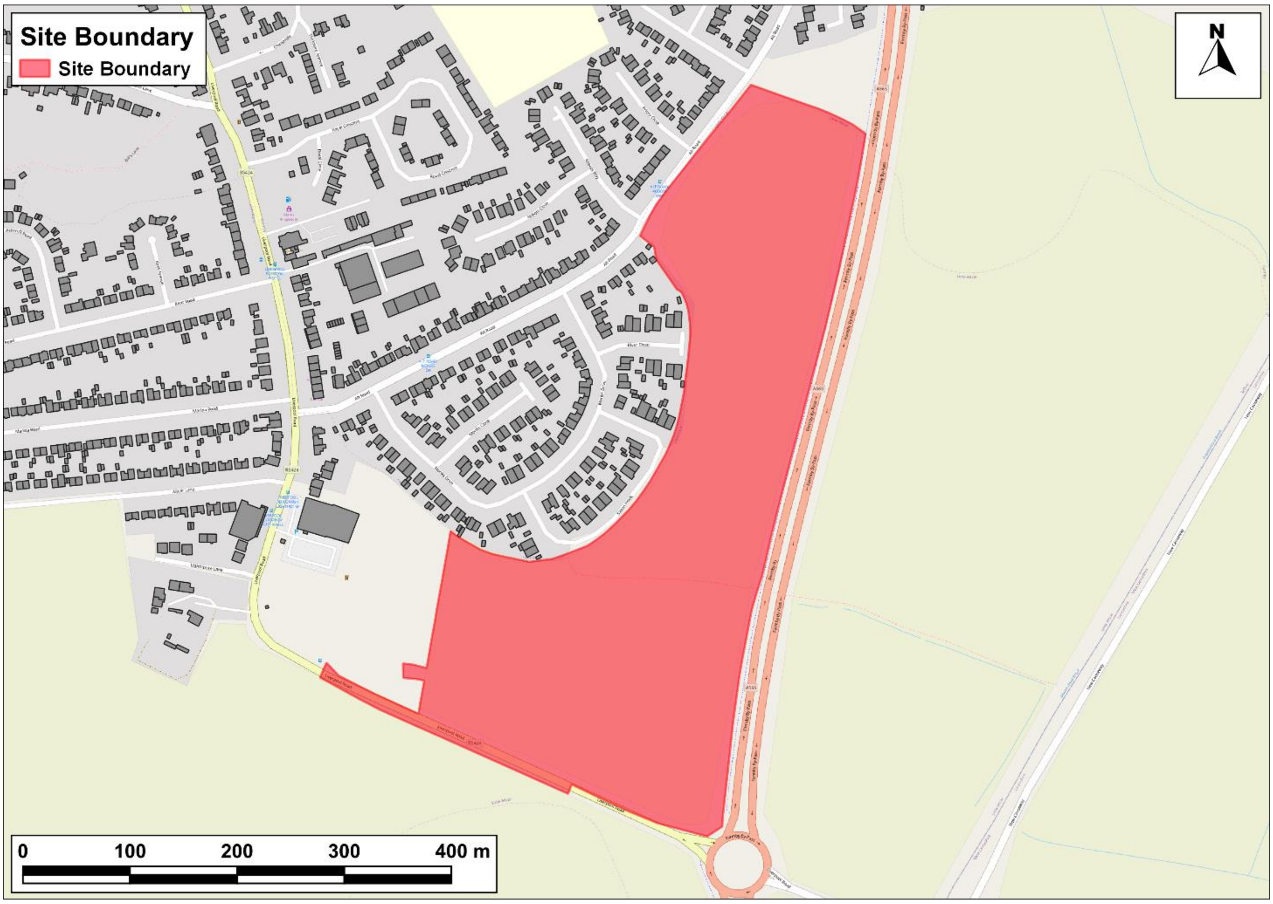
2.1 The site is bounded to the east by Formby By-Pass and to the South by Liverpool Road. The area to the west of the site is made up predominantly of residential properties on Alt Road and Savon Hook which bound the site to the west.

2.2 An agricultural assessment was undertaken in support of the planning application by Reading Agricultural Consultants Ltd in May 2013. Section 4.1 of the report states the following regarding the soil type across the site:

"The underlying bedrock geology at the Site is that of the Sidmouth Mudstone Formation which consists of mudstones and siltstones. Across most of the Site, superficial windblown deposits of Quaternary sands are also mapped. The bedrock in the south eastern corner of the Site is overlain by alluvium, a locally variable mixture of clay, silt, sand and gravel."

2.3 **Figure 1** presents the boundary of the development site and the relative locations of surrounding receptors.

Figure 1: Development Site Boundary



3 Summary of Piling Methods

3.1 Piling activities have the potential to cause noise and vibration disturbance at nearby community receptors. Piling activities can be split into two main categories:

- bearing piles;
- embedded retaining walls.

3.2 The method of piling can be undertaken by driving, pressing or boring, and the most efficient method is dependent on factors such as the ground conditions, the size and depth of the piles, and environmental factors, such as noise impacts in surrounding communities.

Driven piles

3.3 For driven piles, a hammer is used with force to drive the pile into the ground. The hammer can be dropped from a height, or used to push the pile.

3.4 High noise impacts may not arise from driven piles if they use a vibratory pile driver, but disturbance can occur associated with the continuous forced vibration.

Pressed-in piles

3.5 Pressed-in piles do not use hammering or vibratory driving, and instead a pair of piles are pushed in to the ground using the reaction of a group of adjacent piles.

3.6 The main source of noise from pressed-in piles is from the engine driving the hydraulic power.

Bored piles

3.7 Bored piles are undertaken by means of a rotary piling rig or by impact boring.

3.8 High noise emissions can occur from impact boring, namely intermittent high peaks in noise level.

3.9 For rotary boring the major source of noise is from the engine that supplies the power to perform the drilling, and it is a generally steady noise.

Vibroflotation/vibrocompaction and vibroreplacement/vibrodisplacement

3.10 Vibroflotation or vibrocompaction is using a large vibrating poker to cause compaction. Vibroreplacement or vibrodisplacement is the use of a vibrating poker to form a hole which is then backfilled with graded stone and compacted by the poker.

3.11 Typically, vibrating pokers are actuated by electric or hydraulic motors.

3.12 To reduce the noise of the operation, attention needs to be paid to the generator or power pack as appropriate. Other sources of noise could include pumps when using water flush, or air escaping from the poker when this is exposed.

Deep compaction by dynamic consolidation

3.13 A method for improving the bearing capacity of weak soils and fills by dropping a large tamping weight from a height on to the ground at selected locations. Typically, in the UK tamping weights between 10 t and 20 t are used and are dropped from heights between 10 m and 25 m.

3.14 The tamping weight is normally raised by and dropped from a very large crawler crane and the noise characteristic contains both steady (crane engine) and impulsive (impact of weight on ground) components.

4 Assessment Criteria

Construction Noise & Vibration

4.1 Industry standard practice is to base construction noise and vibration assessment criteria on thresholds advocated within BS 5228-1:2009+A1:2014 ‘Code of practice for noise and vibration control on construction and open sites Part 1: Noise and Part 2: Vibration’.

4.2 Part 1 relates to potential effects on existing and proposed noise sensitive human receptors resulting from noise and vibration from construction activities including piling activities.

4.3 Part 2 provides guidance on the assessment of ground-borne vibration associated with activities such as demolition and construction.

Construction Noise

4.4 The determination of effect thresholds for the construction noise assessment is based upon the methodologies presented within Annex E of BS 5228-1:2009+A1:2014 ‘ABC Method’, and the effect levels set out in the Noise Policy Statement for England (NPSE, 2010), namely:

- NOEL - ‘No Observed Effect Level’: The level below which no effect can be detected;
- LOAEL - ‘Lowest Observed Adverse Effect Level’: The level above which adverse effects on health and quality of life can be detected;
- SOAEL - ‘Significant Observed Adverse Effect Level’: The level above which significant adverse effects on health and quality of life occur; and
- UAEL – ‘Unacceptable Adverse Effect Level’: The level above which adverse effects are unacceptable (as introduced in Planning Practice Guidance Noise (PPG(N), 2014).

4.5 **Table 1** below presents the construction noise criteria for the daytime period at noise sensitive receptors, and their respective NSPE effect levels.

Table 1: Daytime Construction Noise Criteria

Noise Source	Period	LOAEL	SOAEL	UAEL
Construction Noise	Daytime	65 dB $L_{Aeq,\ 12hr}$	75 dB $L_{Aeq,\ 12hr}$	85 dB $L_{Aeq,\ 12hr}$

Construction Vibration

4.6 Piling activities, have the potential to cause vibration induced adverse effects at residential receptors.

4.7 The effect of human exposure to vibration from sources other than blasting is covered in BS 6472-1:2008 ‘Guide to evaluation of human exposure to vibration in buildings: 1-Vibration sources other than blasting 2-Blast-induced vibration’ . The standard provides guidance for predicting human response to vibration in buildings over the frequency range of 0.5 Hz to 80 Hz. It presents frequency-weighting curves for humans exposed to whole-body vibration, advice on measurement methods and methods for assessing continuous, intermittent and impulsive vibrations.

4.8 BS 6472:2008 uses the vibration dose value (VDV $ms^{-1.75}$) to determine the effect of vibration on human receptors within the buildings, as "[p]resent knowledge shows that this type of vibration is best evaluated with the vibration dose value (VDV)." As noted in BS 5228-2:2009:A1:2014, for construction it is considered more appropriate to consider effects of vibration levels in terms of Peak Particle Velocity (PPV mms^{-1}).

4.9 The use of the PPV metric is also consistent with the guidance within BS 7385-2:1993 'Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground-borne vibration', which presents assessment criteria to be applied for the likelihood of cosmetic damage to buildings.

4.10 **Table 2** presents a summary of the assessment criteria given in terms of human building response, derived based on guidance within BS 5228-2:2009:A1:2014 and BS 7385:1993.

Table 2: Vibration limits for human response and building (cosmetic) damage

Vibration Limit PPV mms^{-1}	Effect	Magnitude of Impact
< 0.14	Vibration unlikely to be perceptible	None
0.14	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	Negligible
0.30	Vibration might be just perceptible in residential environments	Minor
1.00	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 the residents	Moderate
7.50	Guide value for cosmetic damage of residential buildings where dynamic loading may lead to resonance	Significant
10.00	Vibration is likely to be intolerable for any more than a very brief exposure to these levels in most building environments	Very Significant

4.11 A significant effect from construction vibration is deemed to occur where there is an exceedance of a magnitude of impact of 1.00 mms^{-1} PPV during the daytime, or 0.30 mms^{-1} PPV during the night-time periods.

5 Construction Noise

Plant Assumptions

5.1 Construction noise predictions require an understanding of the construction phasing and plant assumptions.

5.2 In the absence of information from the contractor, typical plant have been assumed for each of the piling methods, as set out in **Table 3** below. All plant assumptions, including sound power level data have been taken from BS 5228-1:2009:A1:2014. It is noted that for each piling method differing plant from that shown in **Table 3** may be used, and where it has different sound source characteristics, the resultant noise immissions would differ from those shown.

5.3 The BS 5228-1:2009:A1:2014 advocated noise prediction methodology has been used to calculate the distance from the piling activities where construction noise levels are equal to or greater than the 65 dB $L_{Aeq,1hr}$ (façade) LOAEL threshold, as shown in **Table 1**. These distances are shown in **Table 3** also.

5.4 As shown, driven piling has the greatest noise emissions, and areas within 224m are exposed to noise levels at or greater than the 65 dB $L_{Aeq,1hr}$ (façade) LOAEL threshold.

Table 3: Noise Piling Plant Assumptions

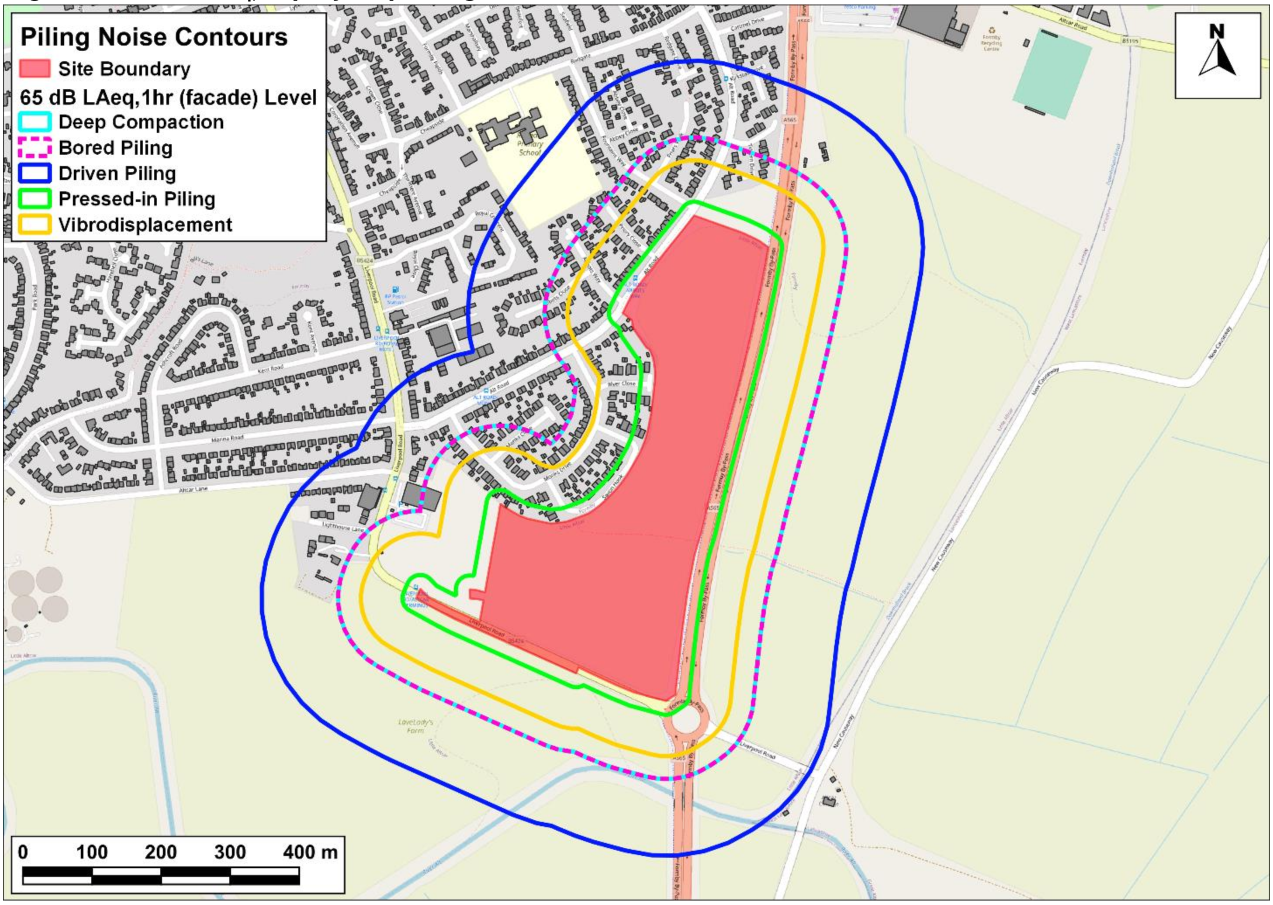
Piling Method	BS5228 ref.	Description	Sound Power Level, Lw dB	Distance (m) to 65 dB $L_{Aeq,1hr}$ (Façade)
Bored Piling	C.3.14	Large rotary bored piling rig, - 110t / 20m deep / 1.2m diameter	111	113
Driven Piling	C.3.1	Hydraulic hammer rig, 145 kW - 16m length / 5t hammer / plywood dolly	117	224
Pressed-in Piling	C.12.1	Pressed-in steel tubular piles; power pack pressing unit, 225 kW	96	20
Vibrodisplacement	C.3.27	Vibrodisplacement and compaction of stone columns, 60 - 17t	108	80
Deep Compaction	C.12.93	Dynamic Compaction, NCK Ajax, 8t, 12m drop	111	113

Community Noise Exposure

5.5 **Figure 2** below presents 65 dB $L_{Aeq,1hr}$ (façade) noise contours for each of the piling methods/ plant types. The noise contours assume piling activities are taking place close to the site boundary, and are therefore worst-case.

5.6 As shown noise contours associated with driven piling have the largest extents, and pressed-in piling, has the smallest extents.

Figure 2: 65 dB $L_{Aeq,1hr}$ (Façade) Piling Noise Contours



5.7 To inform an understanding of the likely impacts associated with each of the piling methods, the number of buildings within each noise contour has been counted using open source GIS data. The number of buildings within each contour is summarised in **Table 4** below.

Table 4: Number of buildings within LOAEL noise contour

Piling Method	Number of Buildings Within 65 dB $L_{Aeq,1hr(façade)}$ LOAEL Contour
Bored Piling	400
Driven Piling	861
Pressed-in Piling	53
Vibrodisplacement	261
Deep Compaction	261

5.8 As shown, driven piling activities close to the boundary of the site has the potential to expose more than 800 properties to noise levels greater than the LOAEL threshold.

5.9 In comparison, pressed-piling has the potential to expose approximately 50 properties.

6 Construction Vibration

Plant Assumptions

6.1 Due to prediction uncertainties associated with the quantification of vibration magnitudes set back distances at which 1.00 mms^{-1} PPV would occur have not been calculated.

6.2 However, historic measurement data is available in BS 5228-2:2009:A1:2014, which presents measured PPV levels for the different piling methods at a variety of distances and soil types.

6.3 For the purpose of this assessment, historic data associated with piling activities in 'clay' soil types has been assumed. This is in reference to the Agricultural Consultants Ltd report (May 2013).

6.4 It should be noted that NCL do not have competencies with respect to the interpretation soil structure surveys, and therefore the findings of the vibration assessment are for informative purposes only.

6.5 The vibration plant assumptions are presented in **Table 5** below, and the distance at which the stated PPV levels were measured.

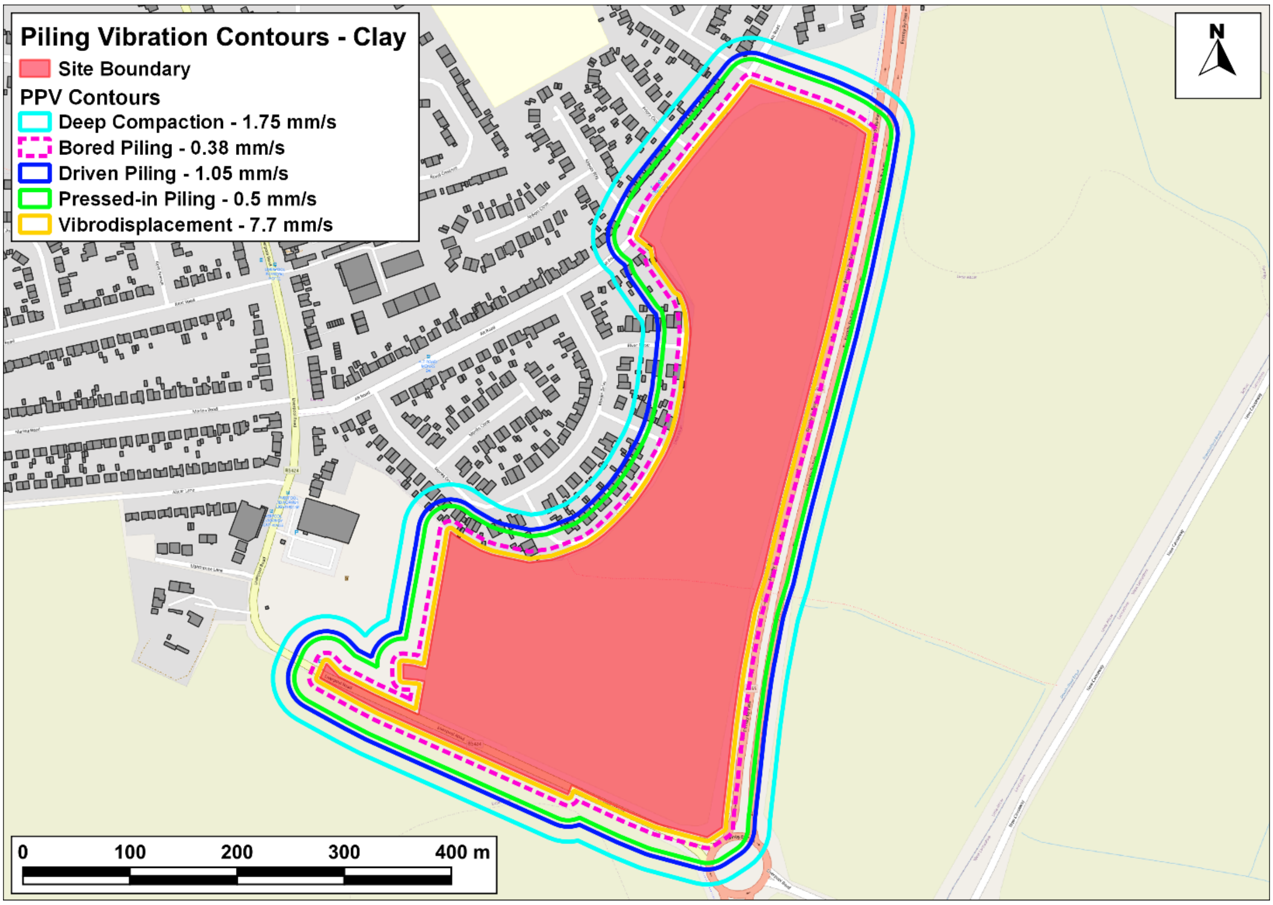
Table 5: Vibration Plant Assumptions

Piling Method	BS5228 ref.	Description	Soil Type	PPV, mms^{-1}	Distance from Plant (m)
Bored Piling	D.6.103	Rotary bored piling (including casing dollies), augering, 350 mm.	Clay fill	0.38	10
Driven Piling	D.2.27	Driven cast-in-place piling (drop hammer), driving tube, top driven, 350 mm.	Clayey fill	1.05	30
Pressed-in Piling	C.1.1	Pressed-in steel sheet piles, U shaped sheet piles.	Soft clay to medium stiff clay	0.50	24
Vibrodisplacement	D.4.85	Vibroflotation/Vibroreplacement piling, airflush.	Miscellaneous fill over stiff clay	7.70	3.5
Deep Compaction	D.3.35	Dynamic consolidation, dropping onto virgin ground.	Clay fill	1.75	44

Community Vibration Exposure

6.6 The vibration magnitudes for each of the piling activities when undertaken in the vicinity of the site boundary are shown in **Figure 3**.

Figure 3: Piling Vibration Magnitude Contours



6.7 To inform an understanding of the likely impacts associated with each of the piling methods, the number of buildings within each vibration magnitude contour has been counted using open source GIS data. The number of buildings within each contour is summarised in **Table 6**.

Table 6: Number of buildings within vibration magnitude contour

Piling Method	PPV (mms^{-1})	Number Building Within Vibration Contour
Bored Piling	0.38	19
Driven Piling	1.05	86
Pressed-in Piling	0.5	78
Vibrodisplacement	7.7	8
Deep Compaction	1.75	147

6.8 With reference to the vibration effect descriptions summarised in **Table 2**, **Table 6** shows that during bored piling there are approximately 19 buildings where vibration is at least 'just perceptible'.

6.9 During driving piling and deep compaction there are 86 and 147 buildings, respectively, where vibration will at least cause a complaint.

6.10 In the event that vibrodisplacement piling activities are proposed, there is the potential for vibration induced cosmetic damage at approximately 8 buildings, and complaints at many more.

7 Conclusions

7.1 This report considers the potential for adverse noise and vibration impacts from piling activities at a residential development on Liverpool Road, Formby.

7.2 The report has considered the potential impacts associated with five piling methods, namely:

- Bored piling;
- Driven piling;
- Pressed-in piling;
- Vibrodisplacement piling; and
- Deep compaction piling.

7.3 During piling activities in the vicinity of the site boundary, all piling methods have the potential to exceed noise threshold criteria without appropriate mitigation. Of the methods considered, and based on the assumptions stated in this report, pressed-in piling is considered to be the most preferable on noise grounds. Driven piling is shown to be the least preferable on noise grounds.

7.4 In terms of vibration, all piling methods have the potential to result in perceivable vibration at multiple buildings, with some methods having the potential to cause cosmetic damage, such as vibrodisplacement.

7.5 With reference to the provisions set out within ‘A Local Plan for Sefton’ (2017) and the obligations set out within the CoPA (1974), appropriate mitigation and consideration of Best Practicable Means should be taken in to account by the contractor prior to any further proposed piling works.