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TABLES

9.0 NOISE AND VIBRATION

9.1 Introduction

9.1.1 This chapter of the Environmental Statement (ES) addresses the potential noise[1] and vibration effects resulting from the Proposed Development on local Noise Sensitive Receptors (NSR).

9.1.2 Impacts during the construction, operation (including maintenance) and decommissioning of the Proposed Development are assessed. In particular, the assessment considers:

- existing and future baseline conditions;
- the effects of construction of the Proposed Development on NSR during the site clearance and construction works including predicted changes in road traffic noise levels on the local road network;
- the effects of noise and vibration resulting from operation of the Proposed Development; and
- the effects of noise and vibration resulting from decommissioning of the Proposed Development.

9.1.3 The cumulative effects of noise associated with the Proposed Development and other committed developments in the vicinity are described in **Chapter 19**: Cumulative and Combined Effects (ES Volume I - **Application Document Ref. 6.2**).

9.1.4 This chapter is supported by **Figures 9.1 – 9.3B** (ES Volume III – **Application Document Ref. 6.4**) and **Appendix 9A:** Construction Noise Assessment Methodology and **Appendix 9B:** Operational Noise Information (ES Volume II – **Application Document Ref. 6.3**).

9.1.5 This chapter assesses the impacts of noise and vibration on residential and other human receptors. The assessment of noise and vibration impacts on relevant ecological receptors is presented in **Chapter 11**: Biodiversity and Nature Conservation (ES Volume I - **Application Document Ref. 6.2**) and the Habitat Regulations Assessment Screening Report (**Application Document Ref. 5.12**) submitted with the Development Consent Order (DCO) Application.

9.2 Legislation, Planning Policy and Guidance

9.2.1 This Section discusses the legislation, planning policy context and standards relevant to assessing the impacts of noise on residential and other human

[1] In this chapter “noise” and “sound” refer to in air noise and sound rather than underwater noise and sound as is the case in **Chapter 11**: Biodiversity and Nature Conservation (ES Volume I – Application Document Ref. 6.2).

receptors. The legislation, planning policy context and standards applicable to assessment of noise impacts on the relevant ecological and cultural heritage receptors are discussed respectively in **Chapter 12**: Water Resources and Flood Risk and **Chapter 15**: Cultural Heritage (ES Volume I - **Application Document Ref. 6.2**).

Legislation

Environmental Protection Act 1990

9.2.2 The Environmental Protection Act (EPA) 1990 Part 3 identifies that noise (and vibration) emitted from premises (including land) can, at certain levels, be prejudicial to health or give rise to statutory nuisance.

9.2.3 Local Authorities are required to investigate any public complaints of noise and if they are satisfied that a statutory nuisance exists, or is likely to occur or recur, they must serve a noise abatement notice. A notice is served on the person responsible for the nuisance. It requires either the abatement of the nuisance or works to abate the nuisance to be undertaken, or it prohibits or restricts the relevant activity. Contravention of a notice without reasonable excuse is an offence. Right of appeal to the Magistrates Court exists within 21 days of the service of a noise abatement notice.

9.2.4 In determining if a noise complaint amounts to a statutory nuisance, the Local Authority can take account of various guidance documents and existing case law; however, no statutory noise limits exist. Demonstrating the use of 'Best Practicable Means' (BPM) to minimise noise levels is an accepted defence against a noise abatement notice.

Control of Pollution Act 1974

9.2.5 Sections 60 and 61 of the Control of Pollution Act 1974 (CoPA) provide the main legislation regarding demolition and construction site noise and vibration. If noise complaints are received, a Section 60 notice may be issued by the local planning authority with instructions to cease work until specific conditions to reduce noise have been adopted.

9.2.6 Section 61 of the CoPA provides a means for applying for prior consent to undertake noise generating activities during construction. Once prior consent has been agreed under Section 61, a Section 60 notice cannot be served provided the agreed conditions are maintained on-site.

9.2.7 The CoPA requires that BPM (as defined in Section 72 of CoPA) be adopted for construction noise on any given site. CoPA makes reference to British Standard 5228 (British Standards Institute (BSI), 2014a and b) (herein referred to as 'BS 5228) as BPM.

Environmental Permitting Regulations 2016 (as amended)

9.2.8 The Environmental Permitting (England and Wales) Regulations 2016 (EPR) require the application of Best Available Techniques (BAT) to activities performed within installations regulated by the legislation in order to manage the impact of these operations on the surrounding environment. The Environmental Permit applies only to the operational and decommissioning phase, not to the construction phase.

9.2.9 In terms of noise specifically, the selection of BAT will have to be considered and balanced with releases to different environmental media (air, land and water) and to give due consideration to issues such as usage of energy and raw materials. Noise, therefore, cannot be considered in isolation from other impacts on the environment.

9.2.10 The definition of pollution in regulation 2 of the EPR includes *"emissions which may be harmful to human health or the quality of the environment, cause offence to human senses or impair or interfere with amenities and other legitimate uses of the environment"* . BAT is therefore likely to be similar, in practice, to the requirements of the Statutory Nuisance legislation which requires the use of BPM to prevent or minimise noise nuisance. In the case of noise, "offence of any human senses" may be judged by the likelihood of complaints. However, the lack of complaint should not necessarily imply the absence of a noise problem. In some cases, it may be possible, and desirable, to reduce noise emissions still further at reasonable costs and this may therefore be BAT for the control of noise emissions from an installation. Consequently, the aim of BAT should be to ensure that there is no reasonable cause for annoyance to persons beyond the installation boundary.

9.2.11 Guidance regarding Environmental Permitting and noise is available in the Environment Agency's Integrated Pollution Prevention and Control (IPPC) H3 document 'Horizontal Guidance for Noise Part 2 - Noise assessment and Control' (Environment Agency, 2002a). However, 'Horizontal Guidance for Noise Part 1 – Regulation and Permitting' (Environment Agency, 2002b), which provided useful guidance relating to noise limits from industrial installations in terms of absolute *rating levels* and *rating levels* relative to *background sound levels* (as defined in BS 4142:1997 (now superseded)) was withdrawn in February 2016. Therefore, industry wide noise limits no longer apply.

Planning Policy Context

National Planning Policy

9.2.12 National Policy Statements (NPS) are, where in place, the primary basis for the assessment and determination of applications for Nationally Significant Infrastructure Projects (NSIP), such as the Proposed Development. Section 5.11 of the Overarching National Policy Statement (NPS) for Energy (EN-1) (Department of Energy & Climate Change (DECC) 2011) refers to the Government's policy on noise within the Noise Policy Statement for England

(NPSE) (discussed further below) and sets out requirements for noise and vibration assessment for NSIP.

9.2.13 With regards to decision making, NPS EN-1 states:

"The project should demonstrate good design through selection of the quietest cost-effective plant available; containment of noise within buildings wherever possible; optimisation of plant layout to minimise noise emissions; and, where possible, the use of landscaping, bunds or noise barriers to reduce noise transmission." (paragraph 5.11.8)

9.2.14 Section 9.5 describes the impact avoidance measures identified as relevant to the Proposed Development.

9.2.15 The NPS for Fossil Fuel Electricity Generating Infrastructure (EN-2) (DECC, 2011b) sets out policy specific to fossil fuel power stations. In paragraph 2.7.1, specific sources of noise are identified. Those that are relevant to the Proposed Development include *'the gas and steam turbines that operate continuously during normal operation'*. It then reiterates the point made in NPS EN-1, stating that:

"The primary mitigation for noise from fossil fuel generating stations is through good design, including enclosure of plant and machinery in noise-reducing buildings wherever possible and to minimise the potential for operations to create noise'. It goes on to state that 'Noise from gas turbines should be mitigated by attenuation of exhausts to reduce any risk of low-frequency noise transmission." (paragraph 2.7.5)

9.2.16 Table 9.1 provides a summary of the NPS advice regarding noise and vibration and how each has been considered in this chapter.

Table 9.1: Summary of relevant NPS advice regarding noise and vibration

Summary of NPS	Consideration within chapter
NPS-EN1	
Paragraph 5.11.4 states: *"Where noise* impacts *are likely to arise from the proposed development, the applicant should include the following in the noise assessment:* • *A description of the noise generating aspects of the development proposal leading to noise impacts, including the identification of any distinctive, tonal, impulsive or low frequency characteristics of the noise;* • *Identification of noise sensitive premises and noise sensitive areas that may be affected;*	Descriptions of noise generating aspects of the Proposed Development, together with assessment of construction, operational and decommissioning noise and vibration impacts are presented in Section 9.6. NSR including proximity of any Noise Important

Summary of NPS	Consideration within chapter
• *The characteristics of the existing noise environment;* • *A prediction of how the noise environment will change with the proposed development;* • *In the shorter term such as during the construction period;* • *In the longer term during the operating life of the infrastructure;* • *At particular times of the day, evening and night as appropriate;* • *An assessment of the effect of predicted changes in the noise; and* • *Measures to be employed in mitigation noise.* *The nature and extent of the noise assessment should be proportionate to the likely noise impact."*	Areas (NIA) are identified in Table 9.4. Information relating to the existing noise environment is presented in Section 9.4. The mitigation of construction and operational noise is discussed in Section 9.5 and 9.7.
Paragraph 5.11.5 states: "The noise impact of ancillary activities associated with the development, such as increased road and rail traffic movements, or other forms of transportation, should also be considered."	Potential construction related traffic noise effects on human NSR have been assessed in Section 9.6.
Paragraph 5.11.6 states: "Operational noise, with respect to human receptors, should be assessed using the principles of the relevant British Standards and other guidance. Further information on assessment of particular noise sources may be contained in the technology-specific NPSs. In particular, for…electricity networks (EN-5) there is assessment guidance for specific features of those technologies. For the prediction, assessment and management of construction noise, reference should be made to any relevant British Standards and other guidance which also give examples of mitigation strategies."	Potential operational noise effects on human NSR are presented in Section 9.6.
Paragraph 5.11.7 states: "The applicant should consult EA and Natural England (NE), as necessary and in particular with regard to assessment of noise on protected species or other wildlife. The results of any noise surveys and predictions may inform the ecological assessment. The seasonality of potentially	Potential effects of noise on biodiversity and nature conservation are considered in **Chapter 11:** Biodiversity and Nature Conservation (ES Volume I - **Application Document Ref. 6.2**) and

Summary of NPS	Consideration within chapter
affected species in nearby sites may also need to be taken into account."	Habitat Regulations Assessment Screening Report (**Application Document Ref. 5.12**) submitted with the DCO Application.
Paragraph 5.11.8 states "The project should demonstrate good design through selection of the quietest cost-effective plant available; containment of noise within buildings wherever possible; optimisation of plant layout to minimise noise emissions; and, where possible, the use of landscaping, bunds or noise barriers to reduce noise transmission."	Section 9.5 of this chapter describes the impact avoidance measures identified as relevant to the Proposed Development.
NPS EN-2	
Paragraph 2.7.2 states: *"The ES should include a noise assessment as described in Section 5.11 in EN-1."*	A noise assessment is included within this chapter.

National Planning Policy Framework

9.2.17 The National Planning Policy Framework (NPPF) (MHCLG, 2019a) is a matter which the Secretary of State is likely to consider both *"relevant and important"* in determining an application for a DCO. Although not directly applicable to NSIP, it sets out the Government's planning policies for England and how these are expected to be applied. The Framework supersedes the previous guidance document Planning Policy Guidance 24 'Planning and Noise' (Office of the Deputy Prime Minister (ODPM), 1994).

9.2.18 The NPPF sets out that planning should make sufficient provision for *"conservation and enhancement of the natural, built and historic environment"* (Paragraph 20d). Consequently, the aim is to prevent both new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of noise pollution.

9.2.19 Paragraph 170 of the NPPF states that:

"planning policies and decisions should contribute to and enhance the natural and local environment by:

……preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air

and water quality, taking into account relevant information such as river basin management plans."

9.2.20 Paragraph 180 states that:

"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

- mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development - and avoid noise giving rise to significant adverse impacts on health and the quality of life;… [and]
- identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason".

9.2.21 With regards to 'adverse effects' and 'significant adverse effects' the NPPF (MHCLG, 2019) refers to the Noise Policy Statement for England Explanatory Note (NPSE) (Department for Environment, Food and Rural Affairs (Defra), 2010), which is described below.

Noise Policy Statement for England

9.2.22 The NPSE (Defra, 2010) seeks to clarify the underlying principles and aims in existing policy documents, legislation and guidance that relate to noise. The NPSE (Defra, 2010) applies to all forms of noise, including environmental noise, neighbour noise and neighbourhood noise.

9.2.23 The statement sets out the long-term vision of the government's noise policy, which is to:

"promote good health and a good quality of life through the effective management of noise within the context of policy on sustainable development".

9.2.24 This long-term vision is supported by three aims:

- *"avoid significant adverse impacts on health and quality of life;*
- *mitigate and minimise adverse impacts on health and quality of life; and*
- *where possible, contribute to the improvements of health and quality of life."*

9.2.25 The long-term policy vision and aims are designed to enable decisions to be made regarding what is an acceptable noise burden to place on society.

9.2.26 The 'Explanatory Note' within the NPSE (Defra, 2010) provides further guidance on defining 'significant adverse effects' and 'adverse effects' using the concepts:

- No Observed Effect Level (NOEL) - the level below which no effect can be detected. Below this level no detectable effect on health and quality of life due to noise can be established;
- Lowest Observable Adverse Effect Level (LOAEL) - the level above which adverse effects on health and quality of life can be detected; and
- Significant Observed Adverse Effect Level (SOAEL) - the level above which significant adverse effects on health and quality of life occur.

9.2.27 The three aims can therefore be interpreted as follows:

- the first aim is to avoid noise levels above the SOAEL;
- the second aim considers situations where noise levels are between the LOAEL and SOAEL. In such circumstances, all reasonable steps should be taken to mitigate and minimise the effects. However, this does not mean that such adverse effects cannot occur; and
- the third aim seeks, where possible, to positively improve the health and quality of life through the pro-active management of noise whilst also taking account of the guiding principles of sustainable development. It is considered that the protection of quiet places and quiet times as well as the enhancement of the acoustic environment will assist with delivering this aim.

9.2.28 The NPSE (Defra, 2010) recognises that it is not possible to have uniform objective noise-based measures that define the SOAEL, LOAEL and NOEL that are applicable to all sources of noise in all situations. The levels are likely to be different for different noise sources, receptors and times of the day.

Planning Practice Guidance - Noise

9.2.29 The Planning Practice Guidance (PPG) (MHCLG, 2019b) was first published on 6th March 2014 to provide a web-based resource with more in-depth guidance to the NPPF (MHCLG, 2019). The PPG aims to make planning guidance more accessible, and to ensure that the guidance is kept up to date. The PPG was last updated for noise in July 2019.

9.2.30 The guidance advises that local planning authorities should take account of the acoustic environment and consider:

- whether or not a significant adverse effect is occurring or likely to occur;
- whether or not an adverse effect is occurring or likely to occur; and
- whether or not a good standard of amenity can be achieved.

9.2.31 This guidance introduced the additional concepts of NOAEL (No Observed Adverse Effect Level), and UAEL (Unacceptable Adverse Effect Level). Full details of the PPG on effects are provided in Table 9.2.

Table 9.2: Planning Practice Guidance noise advice

Perception	Examples of outcomes	Effect level	Action
Not noticeable	No effect	No Observed Effect	No specific measures required
Noticeable and not intrusive	Noise can be heard but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid

Perception	Examples of outcomes	Effect level	Action
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

9.2.32 Factors to be considered in determining if noise is a concern are identified including the absolute noise level of the source, the existing ambient noise climate, time of day, frequency of occurrence, duration, character of the noise and cumulative impacts.

9.2.33 With particular regard to mitigating noise impacts on residential development, the guidance highlights that impacts may be partially off-set if residents have access to a relatively quiet façade as part of their dwelling, or a relatively quiet amenity space (private, shared or public).

Local Development Plan Policy – North Lincolnshire Council (NLC)

9.2.34 North Lincolnshire Council does not have a specific policy relating to noise. However, the council adopted its Core Strategy in June 2011 (NLC, 2011) as part of the Local Development Framework and has a Supplementary Planning Document entitled Planning for Health and Wellbeing that was published in November 2016 (NLC, 2016). It recognises that noise is an issue that can have an effect on physical and mental health.

9.2.35 Policy 3 of Planning for Health and Wellbeing - "Well Designed Places" - states:

"When considering the detail of development, proposals should:

Seek to reduce noise and air pollution through ensuring planning applications include a Noise Impact Assessment…… in areas of concern."

9.2.36 Details of additional consultation with NLC regarding the scope of noise and vibration assessment are given in Table 9.3.

Other guidance

British Standard 7445-1:2003 and 7445-2:1991

9.2.37 BS 7445 'Description and measurement of environmental noise' (BSI, 1991 and 2003) defines parameters, procedures and instrumentation required for noise measurement and analysis.

British Standard 5228:2009+A1:2014

9.2.38 BS 5228-1 'Code of practice for noise and vibration control on construction and open sites. Noise' (BSI, 2014a) provides a 'best practice' guide for noise control and includes sound power level (L_w) data for individual plant as well as a calculation method for noise from construction activities. BS 5228-2 'Code of practice provides a 'best practice' guide for noise and vibration control on construction and open sites. Vibration' (BSI, 2014b) provides comparable 'best practice' for vibration control, including guidance on the human response to vibration.

British Standard 6472:2008

9.2.39 BS 6472-1 'Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting' (BSI, 2008), presents recommended frequency weighted vibration spectra (for continuous vibration) and vibration dose values (VDV) (for intermittent vibration), above which adverse comment is likely to occur in residential properties.

British Standard 7385:1993

9.2.40 BS 7385-2 'Evaluation and measurement for vibration in buildings. Guide to damage levels from ground borne vibration' (BSI, 1993) presents guide values for transient and continuous vibration, above which there is a likelihood of cosmetic damage. The standard establishes the basic principles for carrying out vibration measurements and processing the data, with regard to evaluating vibration effects on buildings.

International Organization for Standardization (ISO) 4866:2010

9.2.41 ISO 4866:2010 'Mechanical Vibration and Shock – Vibration of Fixed Structures – Guidelines for the Measurement of Vibrations and Evaluation of Their Effects on Structures' (ISO, 2010) establishes the principles for carrying out vibration measurement and processing data with regard to evaluating vibration effects on structures.

British Standard 4142:2014+A1:2019

9.2.42 BS 4142 'Methods for rating and assessing industrial and commercial sound' (BSI, 2014c) can be used for assessing the effect of noise of an industrial nature, including mechanical services plant noise. The method compares the difference between '*rating level*' of the industrial sound, with the '*background sound level*' at the receptor position.

British Standard 8233:2014

9.2.43 BS 8233 'Guidance on sound insulation and noise reduction for buildings' (BSI, 2014d) defines criteria for noise levels in and around buildings.

ISO 9613-2:1996: Attenuation of Sound during Propagation Outdoors

9.2.44 ISO 9613-2:1996 'Attenuation of Sound during Propagation Outdoors, Part 2: General Method of Calculation' (ISO, 1996) specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources.

Calculation of Road Traffic Noise

9.2.45 Department for Transport (DfT)/ Welsh Office Memorandum 'Calculation of Road Traffic Noise' (CRTN) (DfT/Welsh Office, 1988) describes procedures for traffic noise calculation and measurement and is suitable for environmental assessments of schemes where road traffic noise may have an effect.

Design Manual for Road and Bridges (2020)

9.2.46 The Highways England 'Design Manual for Road and Bridges LA 111 (Revision 2) Noise and Vibration' (DMRB) (Highways England, 2020) provides guidance on the appropriate approach to be taken when assessing the noise and vibration effects arising from all road projects, including new construction, improvements and maintenance. The guidance is also useful for assessing changes in traffic noise levels as a result of non-road projects such as this.

World Health Organization

9.2.47 The World Health Organization's (WHO) 'Environmental Noise Guidelines for the European Region' (WHO, 2018) provides recommendations to protect human health from noise from transportation, wind turbines and leisure. These guidelines do not cover industrial noise, however, recommend that 'Guidelines for Community Noise' (WHO, 1999) should remain valid. This recommends external daytime and evening environmental noise limits, and internal night-time limits to avoid sleep disturbance.

9.2.48 The WHO 'Night Noise Guidelines for Europe' (WHO, 2009) recommend updated guidelines on night-time noise limits to avoid sleep disturbance.

9.3 Assessment Methodology

Consultation

9.3.1 The consultation undertaken with statutory consultees to inform this chapter, including a summary of comments raised *via* the formal scoping opinion (**Appendix 1B**: ES Volume II - **Application Document Ref. 6.3**) and in response to the formal consultation and other pre-application engagement is summarised in Table 9.3.

Table 9.3: Consultation summary table

Consultee approached	Date and nature of consultation	Summary of comments	Summary of response
Secretary of State	June 2020 (Scoping Opinion)	The inspectorate agrees with the proposed scope items including that traffic noise due to the workforce of the operational plant should be scoped out.	Traffic noise due to the workforce of the operational phase of the Proposed Development has been scoped out, as agreed.
		The ES should specify exactly what guidance is being applied to determine significance.	The guidance used has been specified in Section 9.2 and 9.3.
		Ecological receptors should be assessed with suitable behavioural response thresholds.	An assessment of potential noise disturbance impacts on relevant sensitive ecological receptors is included in **Chapter 11**: Biodiversity and Nature Conservation (ES Volume I - **Application Document Ref. 6.2**) and accompanying **Appendix 11H**: Underwater Sound Effects on Fish (ES Volume II - **Application Document Ref. 6.3**).
		Noise and vibration sensitive receptors should be agreed with NLC. The canal and Keadby Lock should be considered noise sensitive.	NLC responded on 27/08/2020 agreeing with the initial selection of NSR chosen. The selection of receptors agreed was extended to include NSR 12 - Keadby Lock (scheduled monument/ Grade II listed building) for the PEI Report

Consultee approached	Date and nature of consultation	Summary of comments	Summary of response
			(AECOM, November 2020). Following statutory consultation on the PEI Report, NSR 1A Roe Farm and NSR 11 South Pilfrey Farm have also been included in the assessment.
		The ES should assess underwater noise and vibration impacts on underwater receptors.	The ES considers noise and vibration impacts on underwater ecological receptors. This is included in **Chapter 11**: Biodiversity and Nature Conservation (ES Volume I - **Application Document Ref. 6.2**) and accompanying **Appendix 11H**: Underwater Sound Effects on Fish (ES Volume II - **Application Document Ref. 6.3**).
Canal and Rivers Trust	Response to PINS Scoping Opinion (June 2020)	Supporting information should be provided to highlight that works on site will not result in adverse vibrations that could damage structures, e.g. the canal wash wall. The Trust advise the scope of the vibration assessment be expanded to ensure appropriate information is submitted to indicate that no adverse vibration effects or damage will occur to the canal or Keadby Lock.	An assessment of potential vibration effects associated with the construction phase of the Proposed Development, including for installation of a cofferdam has been undertaken and is presented within Section 9.6 of this chapter. This includes assessment of potential vibration effects on the canal walls and Keadby Lock.

Consultee approached	Date and nature of consultation	Summary of comments	Summary of response
	Stage 2 (Statutory) Consultation January 2021	The Trust advise that appropriate supporting information will be required to ensure that works on site will not result in adverse vibrations that could result in damage to the canal wash wall, or the structure at Keadby Lock, which is a scheduled ancient monument. The Trust would welcome full confirmation that no additional piling works will occur on the land to the immediate north of Keadby Lock, which would reduce the risk to Keadby Lock. The Trust outlined that although the piling works for the power station would be sited away from the canal, there is a risk that vibrations from construction plant and machinery in the compounds close to the canal could also impose a risk to the canal structure. The Trust note that construction traffic utilising the access route would likely be similar to the weight of traffic involved in Keadby 2. For clarity, and to allow assurances to be made that the bridge structure (and	Keadby Lock (NSR 11) is included in the assessment as a vibration sensitive receptor. No piling works will be undertaken at the Waterborne Transport Offloading Area (Keadby Lock) as the existing infrastructure at Railway Wharf is considered appropriate for the Proposed Development without further upgrades. The HGV and abnormal indivisible load (AIL) strategy for the Proposed Development is outlined in the Framework Construction Traffic Management Plan (CTMP) (**Application Document Ref. 7.2**). The AIL strategy provides a number of alternative routes to transport components to the Proposed Development Site, including via the A18 and over North Pilfrey Bridge which spans the Stainforth and Keadby Canal. The capacity of the bridge is shown in Figure 4 of the Framework CTMP. Where this AIL route is not suitable for

Consultee approached	Date and nature of consultation	Summary of comments	Summary of response
		associated canal) can handle the loading and vibrations of construction traffic for the Proposed Development, the Trust advise that information is provided upon the maximum weight of vehicle involved in both phases.	components, they will be brought into site via one of two other AIL routes identified.
North Lincolnshire Council	Technical engagement (July - August 2020) with Karen Robinson (Environmental Health Officer)	NLC may require that operational noise levels (*rating levels*) do not exceed the *background sound level* by more than +3 dB, when assessed in accordance with BS 4142: 2014+A1:2019 'Methods for rating and assessing industrial and commercial sound'.	Significant weight has been given to context considerations in the Keadby 2 Power Station Environmental Statement (Environmental Resources Management (ERM), 2016), including the extent to which residents will have habituated to existing railway and Keadby 1 Power Station noise emissions, and thus the sensitivity of these NSR to noise and use of their properties (indoors and outside). This context assessment has resulted in BS 4142 *rating levels* of up to 14 dB above the *background sound level* at night being classified overall as not significant in the Keadby 2 Power Station ES (ERM, 2016). Further consultation has been undertaken in January 2021 with NLC

Consultee approached	Date and nature of consultation	Summary of comments	Summary of response
			regarding appropriate noise limits and further consideration to the context assessment. The NLC criterion that *rating levels* do not exceed the *background sound level* by more than +3 dB has been adopted as a target criterion in this assessment and the mitigation of key sources required to achieve this criterion are listed in Section 9.7.
North Lincolnshire Council (NLC)	Stage 2 (Statutory) Consultation (January 2021)	NLC note that reference and consideration should be given to: • World Health Organisation Environmental Noise Guidelines for the European Region 2018 • World Health Organisation Guidelines for Community Noise (1999) • World Health Organisation Night Noise Guidelines for Europe (2009) Due to the COVID-19 outbreak it was agreed that use of the baseline sound survey data presented in the Keadby 2 Power Station ES was appropriate to	References to WHO guidance have now been included in Section 9.2. Baseline sound survey data presented in the Keadby 2 Power Station ES have been used to inform this assessment. The COVID-19 outbreak presented challenges in obtaining representative baseline sound levels because typical road, air and rail transport usage has been reduced by travel restrictions and social distancing measures. Other sound sources may also have been affected – for example, due to changes in operating patterns at industrial and commercial

Consultee approached	Date and nature of consultation	Summary of comments	Summary of response
		inform the assessments in the PEI Report. NLC would like clarification on why the assessment of construction vibration has been scoped out due to the distance from receptors stated as a minimum of 475 metres. Clarification is required on this matter as the distance to receptors as detailed in Table 9.4 are stated as being 15-20 metres. NLC expect to see the following considered within a CEMP for the proposed development as a minimum: • the works, and the method by which they are to be carried out; • the noise and vibration attenuation measures to be taken to minimise noise and vibration resulting from the works, including any noise limits; and • a scheme for monitoring the noise and vibration during the works to ensure compliance with the noise	premises and reduced school attendance or closures. The approach to monitoring was agreed with NLC via the statutory consultation. Additional baseline data will be collected at the detailed design stage as described in Section 9.4: Baseline Conditions. Potential vibration effects as a result of construction activities on the Main Site (e.g. piling) has been scoped out due to a minimum 400m distance to the closest NSR (Roe Farm). However, assessment of vibration from the installation of a cofferdam for the water abstraction options has not been scoped out and has been assessed given the close proximity of NSR. It is not expected any other significant vibration producing activities will occur close to NSR. The measures NLC has requested be included in the final CEMP are included in Section 11.5: Development Design and Impact Avoidance and are reflected

Consultee approached	Date and nature of consultation	Summary of comments	Summary of response
		limits and the effectiveness of the attenuation measures.	in the Framework CEMP that accompanies the Application (**Application Document Ref. 7.1**).
MMO	Stage 2 (Statutory) Consultation January 2021	There is no mention to the sources of data used to support the conclusions given in Sections 9.6.39 and 9.6.41. MMO advise that that is provided. In Table 9.31 (Chapter 9), noise and vibration effects on ecological receptors within the River Trent have been considered to be Negligible/Minor adverse or less (not significant). It is considered that significant adverse effects on the conservation status of lamprey species as a result of direct and indirect barriers to migratory movements are unlikely. MMO note the Applicant's willingness to agree on appropriate timings for a cofferdam installation and are content with the provision of an FMP to support the upcoming works. Appendix 9A presents the construction noise assessment methods for the	An assessment of impacts of underwater sound and vibration on ecological receptors including supporting evidence has been included in **Chapter 11**: Biodiversity and Nature Conservation (ES Volume I - **Application Document Ref. 6.2**) and **Appendix 11H:** Underwater Sound Effects (ES Volume II – **Application Document Ref. 6.3**). Timing of cofferdam installation and removal is described in **Chapter 5**: Construction Programme and Management (ES Volume I – **Application Document Ref. 6.2**) to avoid significant adverse effects on relevant fish.

Consultee approached	Date and nature of consultation	Summary of comments	Summary of response
		proposed development. Table 2 shows a predicted energy level associated with the sheet piling of 116 decibels ("dB"). Appendix 9B shows the noise model settings and assumptions used for this development. However, it is unclear how these values have been estimated and the location(s) of piling on which these assumptions are based have not been described. Clarification should be provided. MMO note that detailed piling methods and a comprehensive UWN assessment have not yet been provided and it is not possible to validate the conclusions reached by the Applicant on minor adverse (not significant) effect from the construction activities on the Humber Estuary. Additionally, during scoping opinion consultation, the MMO highlighted that there was insufficient information on which to provide comments on UWN impacts. Therefore, the MMO recommend that additional advice is sought from their technical	**Appendix 11H:** Underwater Sound Effects on Fish (ES Volume II – **Application Document Ref. 6.3**) provides an assessment of the impacts of piling on the Humber Estuary Ramsar, SAC and SSSI and relevant qualifying species, should the River Water Abstraction Option be selected. Additional engagement with the MMO and their specialist advisers, CEFAS has been undertaken prior to submission of the Application (to confirm the methodology, and to present the findings of the UWN assessment).

Consultee approached	Date and nature of consultation	Summary of comments	Summary of response
		specialists regarding the suitability and robustness of the evidence provided in Chapter 9 and Appendices 9A/9B, as well as any further consultations relating to this application.	
Public Health England	Stage 2 (Statutory) Consultation January 2021	In view of the proximity of residential properties to the water connection, discharge corridors, abnormal indivisible load route and permanent emergency access via Chapel Road; it is recommended that further details are included in each of the chapters regarding the nature of these and any potential impacts from the construction, operational and decommissioning phases. Clearer and more accurate identification, reference and justification for selection of the human health receptors in the assessments is recommended in each of the chapters. Although human health receptors have been selected to be representative of residential dwellings in the area, consideration is needed for	NSR 1 is considered representative of the group of receptors in the vicinity of Vazon Bridge including Roe Farm and the Scunthorpe Sea Cadets who occasionally use the boat station at Keadby. However as Roe Farm is closer to the Main Site than Vazon Bridge, it has been added as an additional NSR (NSR 1A) for the ES. As described in **Chapter 3**: The Site and Surroundings (ES Volume I – **Application Document Ref. 6.2**) a property 'Red House' shown on OS base planning was demolished in 2019 and is therefore not included as a NSR.

Consultee approached	Date and nature of consultation	Summary of comments	Summary of response
		inclusion of Red House and adjacent properties which are in close proximity to the Main site (noted to be adjacent to emergency vehicle access road), Roe Farm, and Scunthorpe Sea Cadets (youth group), which have not been acknowledged.	

Summary of key changes to **Chapter 9**: Noise and Vibration since publication of the Preliminary Environmental Information (PEI) Report and PEI Report Addendum

9.3.2 The PEI Report was published for statutory consultation in November 2020, allowing consultees the opportunity to provide informed comment on the Proposed Development, the assessment process and preliminary findings through a consultation process, prior to the finalisation of this ES. A PEI Report Addendum was subsequently published in March 2021 following minor changes that were made to the indicative Order Limits since the formal Stage 2 consultation.

9.3.3 The key changes relevant to this chapter since the PEI Report and PEI Report Addendum were published and are summarised in Table 9.4, below.

Table 9.4: Summary of key changes to chapter since publication of the PEI Report and Addendum

Summary of change since PEI Report and Addendum	Reason for change	Summary of change to chapter text in the ES
North of Keadby Village (formerly NSR 11) has been removed from the assessment.	This NSR at PEI stage had originally been included specifically to assess impacts of a potential cofferdam that had been under consideration at the point of cooling water discharge to the river Trent to the north of the Site. As this cofferdam is no longer proposed at the Water Discharge Corridor outfall, this NSR has been removed.	Receptor removed from Table 9.13, Table 9.15, Table 9.16 and Table 9.21 of this Chapter.
NSR 1A Roe Farm has been added to the assessment.	Through consultation with Public Health England.	Receptor added to Table 9.13, Table 9.15 - Table 9.21, Table 9.23 - Table 9.25, Table 9.29 – Table 19.34 of this Chapter.
Construction noise predictions updated for the final order limits and works	To reflect the final Proposed Development	Table 9.19, Table 9.20 and Table 9.23

Summary of change since PEI Report and Addendum	Reason for change	Summary of change to chapter text in the ES
plans (**Application Document Ref. 4.3**).	locations for relevant works.	- Table 9.25 of this Chapter updated.
Operational noise modelling has been updated.	Updated to reflect latest assumptions scheme information.	Updates to operational noise Section of this Chapter.
Requirements for attenuation of plant items have been included.	This has been included to show how a mitigated scenario can be achieved that meets the NLC operational noise criterion.	Inclusion of Table 9.35 in this Chapter.
Assessment of the construction noise effects associated with the A18 widening and replacement of Mabey Bridge has been included. The closest receptor, South Pilfrey Farm (named NSR 11 to replace the Keadby Village NSR that was removed), has been added to the assessment.	To provide an assessment of the potential construction noise effects of the Proposed Development.	Assessment of replacement of Mabey Bridge added to Section 9.6.
An assessment of vibration effects of cofferdam installations for the River Water and Canal Water Abstraction Options has been undertaken.	To address consultee comments.	The approach to assessment and results are provided in **Appendix 11H:** Underwater Sound Effects on Fish (ES Volume II – **Application Document Ref. 6.3**) and Section 9.6 of this chapter.

Overview

9.3.4 Details of the assessment methodologies are provided within **Appendix 9A**: Construction Noise Assessment Methodology and **Appendix 9B**: Operational Noise Information (ES Volume II – **Application Document Ref. 6.3**). These technical appendices provide detailed descriptions of the sensitive human

receptors and the methodology for assessing the impacts of construction and operational noise emissions of the Proposed Development.

Study area

9.3.5 The extent of the study area has been defined to include the NSR/ communities in each direction from the Proposed Power and Carbon Capture Site (Proposed PCC Site) and work areas including Gas Connection Corridor, Electricity Connection Corridor, Water Abstraction and Discharge Corridors and Mabey Bridge/ A18 works. Study areas have also been informed by changes in road traffic flows predicted during the construction phase of the Proposed Development. The extent of the study areas (1km) is shown in **Figure 9.2**: Main Civil Works Construction Noise Level Predictions, **Figure 9.3a**: Operational Noise Level Predictions (Unmitigated Scenario) and **Figure 9.3b**: Operational Noise Level Predictions (Mitigated Scenario) (ES Volume III – **Application Document Ref. 6.4**).

Determining baseline conditions and noise and vibration sensitive receptors

9.3.6 The location of potential NSR in proximity to the Proposed Development Site boundary has been considered when assessing the effects associated with noise and vibration levels from the construction, operational (including maintenance) and decommissioning phases of the Proposed Development.

9.3.7 Key NSR locations selected considered representative of the nearest and potentially most sensitive existing receptors to the Proposed Development have been identified. It is considered that if noise and vibration levels are suitably controlled at the key receptors identified, then noise and vibration levels will be suitably controlled at other sensitive receptors in the surrounding area. The NSR are shown in Table 9.5 and illustrated on **Figure 9.1**: Noise Sensitive Receptors (ES Volume III – **Application Document Ref. 6.4)**.

Table 9.5: Potential noise sensitive receptors

Receptor	Sensitivity/ value of receptors	Direction from Proposed Development Site	Distance from Proposed Development Site boundary (m)*
NSR 1 – Vazon Bridge	High	South	40
NSR 1A – Roe Farm**	High	South	40
NSR 2 – Hawthorne House, Chapel Lane	High	East	35
NSR 3 – Keadby Village	High	North-east	40
NSR 4 – Mariners Arms Flats***	High	East	20

Receptor	Sensitivity/ value of receptors	Direction from Proposed Development Site	Distance from Proposed Development Site boundary (m)*
NSR 5 – Trent Side	High	South-east	150
NSR 6 – 9 Queens Crescent	High	South-east	435
NSR 7 – Keadby Grange	High	East	510
NSR 8 – North Pilfrey Farm	High	South-west	115
NSR 9 – Ealand Poultry Farm	High	West	1,250
NSR 10 – North Moor Farm	High	North-east	475
NSR 11 – South Pilfrey Farm****	High	South-west	250
NSR 12 – Keadby Lock (scheduled monument/Grade II listed building)*****	High value (as defined in **Chapter 15**: Cultural Heritage (ES Volume I – **Application Document Ref. 6.2**).)	South of Waterborne Transport Offloading Area	15

* Distance from the closest point to the Proposed Development Site boundary reported.

** NSR 1A is considered part of the group of receptors in the vicinity of Vazon Bridge including Roe Farm (residential) and the Scunthorpe Sea Cadets (recreational) so uses the same baseline data. However, as NSR 1A is slightly closer to the Main Site it has been assessed separately.

*** NSR 4 is considered representative of the group of properties at Mariners Arms Flats (including the residential property 'Blacksmiths Cottage', formerly Trentvale Preparatory School), therefore distances used in calculations are for the closest of any property in this group to the noise source under assessment.

**** NSR 11 is included for the purposes of assessing impacts related to Mabey Bridge replacement during the construction phase.

***** NSR 12 is assessed for potential vibration effects.

9.3.8 The nearest NIA is located in Scunthorpe on the A18 between the A1077 and Scotter Road roundabouts. This is approximately 3km from the Proposed

Development Site and beyond the study area in which noise effects are considered likely; therefore, noise impacts from the Proposed Development at this location are unlikely and no further assessment is required.

9.3.9 A description of the study areas for ecological receptors are presented in **Chapter 11**: Biodiversity and Nature Conservation (ES Volume I – **Application Document Ref. 6.2**) and accompanying **Appendix 11H:** Underwater Sound Effects on Fish (ES Volume II – **Application Document Ref. 6.3**) which describes the key noise sensitive ecological receptors including migratory species using the River Trent (SPA/ Ramsar site/ SSSI). Further assessment is provided in the Habitats Regulations Assessment Screening Report (**Application Document Ref. 5.12**).

Baseline sound and vibration surveys

9.3.10 The COVID-19 outbreak has presented challenges in obtaining representative baseline sound levels because typical road, air and rail transport usage has been reduced by travel restrictions and social distancing measures. Other sound sources may also have been affected – for example, due to changes in operating patterns at industrial and commercial premises. It was therefore agreed with NLC Environmental Health Officer[2] that use of the baseline sound survey data presented in the Keadby 2 Power Station ES was appropriate, to inform the assessments in this ES.

9.3.11 Baseline sound monitoring to inform Keadby 2 Power Station ES was undertaken at key residential NSR by ERM (2016). This comprised both attended and unattended measurements.

9.3.12 Initial surveys were completed in June, July and August 2015, while Keadby 1 Power Station was not operational, and a further survey was completed in January 2016 while Keadby I Power Station was operational. Measurement data from those surveys have been reviewed for the purposes of this assessment and it was noted that sound levels were sometimes lower when Keadby 1 Power Station was operational. Due to this, and the likely variable effect of meteorological and other ambient conditions in the area during the 2015 and 2016 surveys, the lower of the *ambient* and *background sound level* data obtained by ERM have been used in this assessment to provide a conservative approach.

Assessment of construction and decommissioning noise

9.3.13 At this stage in the project design development, before the appointment of a construction contractor, site specific details regarding the construction activities, programme and numbers and types of construction plant are

[2] Telephone conversation with AECOM 28/08/20 in response to AECOM request for technical engagement 30/07/20

unavailable. Therefore, detailed construction noise predictions have not been undertaken. Nevertheless, indicative construction noise predictions have been undertaken using the calculation methods set out in BS 5228 (BSI, 2014a), based upon construction information from other power station projects, including those undertaken by the Applicant. In addition, indicative calculations have been undertaken for works associated with the Gas Connection, Electrical Connection and Water Connection Corridors.

9.3.14 The calculation method provided in BS 5228 (2014a) takes account of factors including the number and types of equipment operating, their associated sound power levels (L_w), their modes of operation (% on-times within the working period), the distance to NSR, and the effects of any intervening ground cover or barrier/ topographical screening. This allows prediction of the magnitude of impact. Construction activities away from the Proposed PCC site are assessed separately to the construction assessment for the Proposed PCC Site because the types of plant and activities are expected to be different. This excludes laydown areas for construction of the Proposed PCC Site which are included in predictions for the Proposed PCC Site. The same significance criteria have been used to assess construction noise from activities on the Proposed PCC Site and away from it.

9.3.15 The subsequent assessment of construction noise effects at residential NSR considers the guidance in 'example method 1 – the ABC method' as defined in BS 5228 (BSI, 2014a). Table 9.6 (reproduced from BS 5228-1) provides guidance in terms of appropriate threshold values for residential NSR, based upon existing ambient noise levels.

Table 9.6: Construction noise threshold values at residential dwellings

Assessment category and threshold value period	Threshold value $L_{Aeq,T}$ dB – free-field		
	Category A (a)	Category B (b)	Category C (c)
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75
Evenings and weekends (d)	55	60	65
Night-time (23:00 – 07:00)	45	50	55
NOTE 1: A potential significant effect is indicated if the LAeq,T noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level. NOTE 2: If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total LAeq,T noise level for the period increases by more than 3 dB due to site noise. NOTE 3: Applies to residential receptors only.			

Assessment category and threshold value period	Threshold value $L_{Aeq,T}$ dB – free-field
(a) Category A: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values. (b) Category B: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as Category A value. (c) Category C: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than Category A values. (d) 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays, 07:00 – 23:00 Sundays.	

9.3.16 For the appropriate period (day, evening, night, weekend etc.), the ambient noise level is determined and rounded to the nearest 5 dB and the appropriate threshold value is then derived. The predicted construction noise level is then compared with this noise threshold value.

9.3.17 Based upon the BS 5228 ABC method (BSI, 2014a), the criterion adopted in this assessment for the determination of potentially significant effects is the exceedance of the $L_{Aeq,T}$ threshold level for the category appropriate to the ambient noise level at each NSR. This is considered to be potentially equivalent to the SOAEL, although as stated in BS 5228, other project-specific factors, such as the number of NSR affected and the duration and character of the impact, should also be considered by the assessor when determining if there is a potentially significant effect.

9.3.18 For residential receptors and other high sensitivity human receptors, the criterion for the LOAEL is a predicted construction noise level equal to the existing ambient noise level at each NSR i.e. resulting in a 3 dB increase in noise level when combined with the existing ambient noise level.

9.3.19 It is noted that the criteria for the LOAEL and SOAEL relate to residential NSR only, in line with the ABC method.

9.3.20 In accordance with the NPPF (MHCLG, 2019) and NPSE (Defra, 2010), it is important to avoid significant adverse effects (at or above the SOAEL) and also mitigate and minimise or other adverse effects (above the LOAEL), where possible. This assessment focuses on the impact at existing residential NSR.

9.3.21 Based upon the above, the magnitude of the impact of construction noise is classified in accordance with the descriptors in Table 9.7.

Table 9.7: Magnitude of construction noise impacts

Magnitude of Impact	Comparison with Threshold Value $L_{Aeq,T}$ dB
High	Exceedance of ABC Threshold Value by ≥+5 dB
Medium	Exceedance of ABC Threshold Value by up to +5 dB
Low	Equal to or below the ABC Threshold Value by up to 5 dB
Very low	Below the ABC Threshold Value by ≥-5 dB

Assessment of construction works traffic on the public highway

9.3.22 The Proposed Development will affect traffic flows on existing roads in the area within and surrounding the Proposed Development Site during construction. The assessment focuses on the impact at NSR located alongside the local road network.

9.3.23 Construction traffic noise has been assessed by considering the increase in traffic flows during the construction works, following the guidance of CRTN (DfT/ Welsh Office, 1988) and DMRB (Highways England, 2020).

9.3.24 18-hour (06:00 – 24:00) Annual Average Weekday Traffic (AAWT) data have been obtained for the year 2031 'with' and 'without' construction traffic during the peak construction period, in order to determine if any existing roads are predicted to be subject to a potentially significant change in 18-hour traffic flows. CRTN Basic Noise Level (BNL) calculations have been undertaken to predict the change in noise level between the 'with' and 'without' scenarios.

9.3.25 The criteria for the assessment of traffic noise changes arising from construction works have been taken from Table 3.17 of DMRB (Highways England, 2020) and are provided in Table 9.8 below.

Table 9.8: Construction traffic noise criteria

Magnitude of impact	Change in traffic noise level $L_{A10,18hr}$ dB
High	≥ 5
Medium	≥3 to <5
Low	≥1 to <3
Very low	<1

9.3.26 DMRB advises that an increase in road traffic flows of 25% (where the traffic speed and composition remain consistent) equates to an approximate increase in road traffic noise of 1 dB $L_{A10,18hr}$. A doubling in traffic flow would be required for an approximate increase of 3 dB $L_{A10,18hr}$.

9.3.27 The criteria are based on the current guidance on short-term changes in traffic noise levels in DMRB. It is generally accepted that changes in noise levels of 1

dB L_A or less are imperceptible, and changes of 1 to 3 dB L_A are not widely perceptible. Therefore, the SOAEL is set at a change in traffic noise of ≥3 dB and the LOAEL at ≥1 dB.

Assessment of Construction Vibration

Impacts on Humans - Annoyance

9.3.28 Vibration due to construction activities has the potential to result in adverse impacts at nearby NSR. The transmission of ground-borne vibration is highly dependent on the nature of the intervening ground between the source and receptor and the activities being undertaken. BS 5228-2: 2009+A1:2014 'Code of Practice for Noise and Vibration Control on Construction and Open Sites - Vibration' (BSI, 2014b) provides data on measured levels of vibration for various construction works, with particular emphasis on piling. Impacts are considered for both damage to buildings and annoyance to occupiers.

9.3.29 Table E.1 of BS 5228-2 contains a general method for calculation of Peak Particle Velocity (PPV) from percussive piling. This method is designed for use on any percussive piling with limited consideration of ground conditions so risks producing exaggerated worst-case levels. Therefore, calculation of PPV vibration levels for installation of a cofferdam for the River Water Abstraction Option and Canal Water Abstraction Option has used measured levels of vibration from hammer driven sheet piling in similar ground types to those found at the Proposed Development Site, as contained in Table D.8 of BS 5228-2. The data have been used to calculate a regression line at the 95% confidence interval using the empirical formula and variables in the BS 5228-2 Table E.1. This regression line can be used to calculate PPV vibration levels at receptors.

9.3.30 Table 9.9 sets out PPV vibration levels and provides a semantic scale for the description of demolition and construction vibration impacts on human receptors, based on guidance contained in BS 5228-2 (BSI, 2014b).

Table 9.9: Construction vibration threshold at residential dwellings

Peak Particle Velocity (PPV) level	Description	Magnitude of impact
>= 10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.	High
1.0 to < 10 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.	Medium
0.3 to < 1.0 mm/s	Vibration might be just perceptible in residential environments.	Low
0.14 to < 0.3 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.	Very low

9.3.31 For residential receptors and other high sensitivity receptors, the LOAEL is defined as a PPV of 0.3 mm/s (millimetres per second); this being the point at which construction vibration is likely to become perceptible. The SOAEL is defined as a PPV of 1.0 mm/s, this being the level at which construction vibration can be tolerated with prior warning.

9.3.32 At receptors above the SOAEL, further consideration of whether an effect is significant is undertaken using professional judgement, taking account of the duration and frequency of the effect, as well as the time of evening/ night that the effect would be experienced.

9.3.33 Given the considerable distance between the Main Site and the closest residential NSR (minimum 400m), no significant vibration (medium or high magnitude) is expected to result from the proposed construction (or demolition) activities at the Main Site and therefore further assessment is scoped out.

9.3.34 Due to the short distance to NSR 4 from the River Water Abstraction Option where sheet piling for installation of a cofferdam may be required, vibration effects on NSR 4 cannot be scoped out and predictions have been made in Section 9.6.

Impacts on Buildings

9.3.35 In addition to human annoyance, building structures may be damaged by high levels of vibration. The levels of vibration that may cause building damage are far in excess of those that may cause annoyance. Consequently, if vibration

levels are controlled to those relating to annoyance (i.e. 1.0 mm/s), then it is highly unlikely that buildings will be damaged by demolition and construction vibration levels.

9.3.36 The criteria used in this assessment relate to the potential for cosmetic damage, not structural damage. The principal concern is generally transient vibration, for example due to piling.

9.3.37 BS 7385-2: 1993 'Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration' (BSI, 1993) provides guidance on vibration levels likely to result in cosmetic damage and is referenced in BS 5228-2:2009+A1:2014 (BSI, 2014b). Guide values for transient vibration, above which cosmetic damage could occur, are given in Table 9.10.

Table 9.10: Transient vibration guide values for cosmetic damage

Type of building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
Unreinforced or light framed structures Residential or light commercial buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
NOTE 1: Values referred to are at the base of the building. NOTE 2: For un-reinforced or light framed structures and residential or light commercial buildings, a maximum displacement of 0.6 mm (zero to peak) is not to be exceeded.		

9.3.38 BS 7385-2 (BSI, 1993) states that the probability of building damage tends to zero for transient vibration levels less than 12.5 mm/s PPV. For continuous vibration, such as from vibratory rollers, the threshold is around half this value.

9.3.39 It is also noted that these values refer to the likelihood of cosmetic damage. ISO 4866:2010 (ISO, 2010) defines three different categories of building damage:

- cosmetic – formation of hairline cracks in plaster or drywall surfaces and in mortar joints of brick/concrete block constructions;
- minor – formation of large cracks or loosening and falling of plaster or drywall surfaces or cracks through brick/block; and
- major – damage to structural elements, cracks in support columns, loosening of joints, splaying of masonry cracks.

9.3.40 BS 7385-2 (BSI, 1993) defines that minor damage occurs at a vibration level twice that of cosmetic damage and major damage occurs at a vibration twice that of minor damage. Therefore, this guidance can be used to define the magnitude of impact identified in Table 9.11 below.

Table 9.11: Magnitude of impact – construction vibration building damage

Magnitude of impact	Damage risk	Continuous vibration level PPV mm/s
High	Major	30
Medium	Minor	15
Low	Cosmetic	6
Very low	Negligible	<6

9.3.41 These values for construction vibration building damage will apply to relevant receptors and structures in the vicinity of any cofferdam works during construction, including residential receptors, the canal wash wall and infrastructure in the vicinity of Keadby Lock.

9.3.42 While predictions are made for vibration levels for sheet piling of a cofferdam for the River Water and Canal Water Abstraction Options, it is considered unlikely that most typical construction working routines would generate levels of vibration above which building damage would be expected to be sustained (subject to final plant and working requirements).

9.3.43 With respect to existing buildings within the Keadby Power Station site, as both the construction of the Proposed Development and the existing buildings are both within the control of the Applicant, any identified issues can be effectively managed by the Applicant and their contractor(s). Potential measures to ensure that appropriate mitigation is in place during the works are discussed in Section 9.5.

Construction vibration impacts (disturbance) on ecological receptors

9.3.44 Where construction works take place at locations close to, or within, the River Trent SAC/ Ramsar site/ SSSI, there is potential for vibration impacts on ecological receptors. This is considered further in **Chapter 11**: Biodiversity and Nature Conservation (ES Volume I - **Application Document Ref. 6.2**) and the Habitat Regulations Assessment Screening Report (**Application Document Ref. 5.12**). Construction vibration will be controlled by the Construction Environmental Management Plan (CEMP); a Framework CEMP is included as **Application Document Ref. 7.1**.

Assessment of operational noise impacts on human beings (NSR)

9.3.45 The assessment of operational sound levels has been based upon calculations taking account of proposed plant and equipment (refer to **Appendix 9B**:

Operational Noise Information (ES Volume II - **Application Document Ref. 6.3**)), sound power levels (L_w) relating to the proposed plant, distance between the proposed plant and NSR and the acoustic screening offered by existing topography and existing and proposed new buildings.

9.3.46 A noise propagation model has been developed using the noise modelling software CadnaA 2021 to assess the current layout options for the Proposed Development. CadnaA implements the noise prediction method ISO 9613-2: 1996 'Attenuation of sound during propagation outdoors' (ISO, 1996), which has been employed to calculate sound levels at surrounding NSR due to operations at the Proposed PCC site (from both proposed external plant and breakout of sound from plant within buildings).

9.3.47 The noise model consists of a three-dimensional representation of an indicative layout of the Proposed PCC Site and its surroundings. The Proposed Development will have a CCGT plant which is broadly similar to Keadby 2 Power Station and therefore operational noise modelling has been based on plant and sound power level data provided by Siemens for the Keadby 2 Power Station ES.

9.3.48 The data have been supplemented with sound level data available from similar CCGT/ CCP projects to allow modelling of the combined key sound sources (i.e. CCGT and CCP) at the Proposed Development, based upon the Indicative Layout of the Proposed PCC Site – see **Figure 4.1** (ES Volume III - **Application Document Ref. 6.4**) and **Application Document Ref. 4.7**. Following discussions with the plant designers, a number of reasonable worst-case assumptions have been made. It has been assumed that the compressor, pumps and CCP absorber stack (including both the stack casing and point of emission to atmosphere) will be designed so that they do not individually exceed a maximum free-field sound pressure level of 85 dB $L_{Aeq,T}$ at 1m external to each CCP building or external plant item. For each pump area, it has been assumed that two pumps will be operating simultaneously.

9.3.49 The CCP absorber and Direct Contact Cooler (DCC) sound power levels have initially been calculated based on the free-field sound pressure level of 85 dB $L_{Aeq,T}$ at 1 m, assuming no additional containment. Both sound sources have then been enclosed in a 100mm thick concrete structure, resulting in a reverberant internal sound environment within each structure. The internal reverberant sound pressure level has been calculated within each structure, and these levels have been used to calculate the sound breakout from each structure, in order to predict noise levels at NSR.

9.3.50 These assumptions will potentially over-estimate the sound power level but is intended to represent a reasonable worst-case assessment.

9.3.51 Topographical features and buildings that may influence the transmission of sound from the Proposed Development to NSR are included in the noise model. A digital terrain model created using ground elevation spot height data has been used to position buildings and other noise sources at the proposed maximum

heights relative to ground. Areas of acoustically soft and hard ground have been identified from the Ordnance Survey MasterMap Topographic Layer and modelled accordingly.

9.3.52 The prediction method assumes that the prevailing wind direction is always from source to receiver, which is likely to overestimate the noise effects associated with the Proposed Development for much of the time for many NSR, given the predominant wind direction in the UK is from the south-west.

9.3.53 Based upon the predicted sound levels from the noise model, an assessment of potential noise impact at nearby NSR has been undertaken using the guidance in BS 4142:2014+A1:2019 'Methods for rating and assessing industrial and commercial sound' (BSI, 2014c).

9.3.54 A key aspect of the BS 4142 (BSI, 2014c) assessment procedure is a comparison between the *background sound level* in the vicinity of residential locations and the *rating level* of the sound source under consideration. The relevant parameters in this instance are as follows:

- *Background sound level* – $L_{A90,T}$ – defined in the Standard as the *"A-weighted sound pressure level that is exceeded by the residual sound for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels"*;
- *Specific sound level* – L_s ($L_{Aeq,Tr}$) – the "*equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, Tr"*; and
- *Rating level* – $L_{Ar,Tr}$ – the *"specific sound level plus any adjustment made for the characteristic features of the sound"*.

9.3.55 BS 4142 (BSI, 2014c) allows for corrections to be applied based upon the presence or expected presence of the following:

- tonality: up to +6 dB penalty;
- impulsivity: up to +9 dB penalty (this can be summed with tonality penalty); and
- other sound characteristics (neither tonal nor impulsive but still distinctive): +3 dB penalty.

9.3.56 Once any adjustments have been made, the *background sound level* and the *rating level* are compared. The standard states that:

- *"Typically, the greater the difference, the greater the magnitude of impact.*
- *A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.*
- *A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.*

- *The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context."*

9.3.57 Importantly, as suggested above, BS 4142 (BSI, 2014c) requires that the *rating level* of the noise source under assessment be considered in the context of the environment when defining the overall significance of the impact.

9.3.58 BS 4142 (BSI, 2014c) suggests that a one-hour assessment period is considered during the day and a 15-minute assessment period at night.

9.3.59 Table 9.12 illustrates the adopted magnitude of impact scale used in this assessment based upon the numerical level difference. For BS 4142 (BSI, 2014c) assessment purposes, the SOAEL is set at a *rating level* above the *background sound level* of +10 dB, and the LOAEL at +5 dB, although it should be remembered that the context assessment (including the absolute level of the sound under consideration) can vary the overall classification of effects.

Table 9.12: Magnitude of impact for industrial noise

Magnitude of impact	**BS 4142 descriptor**	***Rating level* minus *background sound level* (dB)**
High	No BS 4142 descriptor for this magnitude level	>15
Medium	Indication of a significant adverse impact, depending upon context	+10 approx.
Low	Indication of an adverse impact, depending upon context	+5 approx.
Very low	Indication of low effect, depending upon context	≤ 0

Assessment of operational vibration impacts on human beings

9.3.60 The operational equipment at the Proposed PCC Site will comprise precision rotating machinery, which will be monitored and maintained in a high state of balance. This type of equipment therefore does not pass significant levels of vibration into the ground. Taking this into account, and the distances between the proposed indicative locations of equipment and residential NSR, it is not anticipated that operational vibration levels will be significant. Therefore, further assessment of operational vibration from the Proposed PCC Site is scoped out of this assessment.

9.3.61 No significant sources of operational vibration are likely outside of the Proposed PCC Site and therefore, again, further assessment of operational vibration is scoped out of this assessment.

Operational noise and vibration impacts on ecological receptors

9.3.62 Noise and vibration impacts on ecological receptors, including the River Trent, resulting from operation of the Proposed Development on the Main Site are not anticipated to be significant due to the distances involved (>1km) and the control of noise and vibration under the Environmental Permit for the Proposed Development. Further assessment is therefore scoped out.

Receptor sensitivity

9.3.63 Effects are classified based on the magnitude of the impact (as outlined above for the various potential impacts during construction and operation) and the sensitivity or value of the affected receptor. A scale of receptor sensitivity in presented in Table 9.13.

Table 9.13: Sensitivity/value of receptors

Sensitivity/ value of resource/ receptor	Description	Examples of receptor usage
Very high	Receptors where noise or vibration will significantly affect the function of a receptor	Auditoria/studios Specialist medical/teaching centres, or laboratories with highly sensitive equipment
High	Receptors where people or operations are particularly susceptible to noise or vibration	Residential Quiet outdoor areas used for recreation Conference facilities Schools/educational facilities in the daytime Hospitals/residential care homes Libraries
Medium	Receptors moderately sensitive to noise or vibration where it may cause some distraction or disturbance	Offices Restaurants/retail Sports grounds when spectator or noise is not a normal part of the event and where quiet conditions are necessary (e.g. tennis, golf)
Low	Receptors where distraction or disturbance of people	Residences and other buildings not occupied during working hours

Sensitivity/ value of resource/ receptor	Description	Examples of receptor usage
	from noise or vibration is minimal	Factories and working environments with existing high noise levels Sports grounds when spectator or noise is a normal part of the event

Classification of effects

9.3.64 Impacts are defined as changes arising from the Proposed Development, and consideration of the result of these impacts on environmental receptors enables the identification of associated effects, and their classification (major, moderate, minor and negligible, and adverse, neutral or beneficial). Each effect has been classified both before and after mitigation measures have been applied.

9.3.65 The following terminology has been used in the assessment to define effects:

- *adverse – detrimental or negative effects to an environmental resource or receptor;*
- *neutral – effects to an environmental resource or receptor that are neither adverse nor beneficial; or*
- *beneficial – advantageous or positive effect to an environmental resource or receptor.*

9.3.66 The effect resulting from each individual potential impact type above is classified according to the magnitude of the impact and the sensitivity or value of the affected receptor using the matrix presented in Table 9.14 below, but where necessary also considering the context of the acoustic environment.

Table 9.14: Classification of effects

Sensitivity/ value of resource/ receptor	Magnitude of impact			
	High	**Medium**	**Low**	**Very low**
Very high	Major	Major	Moderate	Minor
High	Major	Moderate	Minor	Negligible
Medium	Moderate	Minor	Negligible	Negligible
Low	Minor	Negligible	Negligible	Negligible

9.3.67 Where adverse or beneficial effects have been identified, these have been assessed against the following significance scale, derived using the matrix presented in Table 9.14:

- negligible – imperceptible effect of no significant consequence;

- minor – slight, very short or highly localised effect of no significant consequence;
- moderate – limited effect (by extent, duration or magnitude), which may be considered significant; or
- major – considerable effect (by extent, duration or magnitude) of more than local significance or in breach of recognised acceptability, legislation, policy or standards.

9.3.68 For the purposes of this assessment, negligible and minor effects are considered to be not significant, whereas moderate and major effects are considered to be significant.

Data sources

9.3.69 The following sources of information that define the Proposed Development have been reviewed and form the basis of the assessment of likely significant effects from noise and vibration:

- **Chapter 4**: Proposed Development (ES Volume I – **Application Document Ref. 6.2**);
- **Chapter 5**: Construction Programme and Management (ES Volume I – **Application Document Ref. 6.2**);
- Indicative Layout Plan for the Proposed PCC Site (**Figure 4.1** (ES Volume III – **Application Document Ref. 6.4** and **Application Document Ref. 4.7**);
- sound power level data from Keadby 2 Power Station ES (ERM, 2016);
- sound power level data from used for similar carbon capture projects including Karsto CCS FEED study, Norway (Bechtel Overseas Corporation (2019);
- AAWT traffic data from the Transport Assessment (TA) for the construction phase of the Proposed Development (see **Appendix 10A:** Transport Assessment (ES Volume II - **Application Document Ref. 6.3**)); and
- Ordnance Survey (OS) mapping of the Proposed Development and surrounding area, topographical data (LIDAR data) and aerial photography.

Use of Rochdale Envelope

9.3.70 The assessment of operational noise and vibration has been undertaken using the Rochdale Envelope approach having regard to the Planning Inspectorate (PINS) Advice Note 9 (PINS, 2018). The Rochdale Envelope is applicable where some of the details of a Proposed Development are not able to be confirmed when an application is submitted, and flexibility is needed to address design uncertainty. The three key principles an assessment should adopt are as follows:

- use a cautious worst-case approach;
- the level of information assessed should be sufficient to enable the likely significant effects of a Proposed Development to be assessed; and
- the allowance for flexibility should not be abused to provide inadequate descriptions of projects.

9.3.71 In line with these principles, the following approach has been taken for the construction stage:

- within the Main Site, it has been assumed that fixed plant would be evenly distributed, and mobile plant be evenly distributed through the Main Site and adjacent laydown areas;
- construction activities within the the Electrical Connection to the 132kV Northern Powergrid Substation and Water Connection Corridors have been assumed to take place at the nearest part of the area/ corridor to NSR;
- predictions of noise and vibration resulting from cofferdam piling (River Water Abstraction Option and Canal Water Abstraction Option) are based upon the closest piles to NSR being driven into the riverbank/ canal bank as a worst-case;
- construction activities and plant have been assumed to be in constant operation through the 07:00 to 19:00 working day, see **Appendix 9A**: Construction Noise Assessment Methodology (ES Volume II – **Application Document Ref. 6.3**); and

  predictions made for construction noise in the evening and night-time period assume the same intensity of operation as daytime, again to provide a worst-case.

9.3.72 The following approach has been taken for the operational stage operational assessment:

- sensitivity testing of the key sound source locations has been undertaken to determine the reasonable worst-case scenario. This has included moving the highest contributing sound sources to various locations within the respective Work areas (**Application Document Ref. 4.3**) and reporting the highest predicted sound levels at each NSR;
- the CCP compressors and absorber stack have each been conservatively modelled as producing a free-field design criterion sound pressure level of 85 dB $L_{Aeq,T}$ at 1m, which is likely to overestimate the sound level from low pressure compression;
- the CCP absorber stack casing and stack exhaust (at the point of emission to atmosphere) have been conservatively modelled as producing a free-field design criterion sound pressure level of 85 dB $L_{Aeq,T}$ at 1m;
- pumps for the CCP have each been conservatively modelled as producing a free-field design criterion sound pressure level of 85 dB $L_{Aeq,T}$ at 1m; and

- the CCP Absorber and Direct Contact Cooler (DCC) sound power levels have initially been calculated based on the free-field sound pressure level of 85 dB $L_{Aeq,T}$ at 1m, assuming no additional containment. Both sound sources have then been enclosed in a 100mm thick concrete structure, resulting in a reverberant internal sound environment within each structure. The internal reverberant sound pressure level has been calculated within each structure, and these levels have been used to calculate the sound breakout from each structure, in order to predict noise levels at NSR.

9.3.73 In relation to both construction and operational effects, mitigation, if considered necessary, would be integrated into the detailed design, in order to meet noise limits to be agreed at the nearest NSR, in accordance with Requirements of the draft DCO (**Application Document Ref. 2.1**).

9.4 Baseline Conditions

Existing Baseline

9.4.1 The results from the Keadby 2 Power Station ES baseline sound surveys are provided in Table 9.15. Surveys were undertaken during June, July and August 2015 when Keadby 1 Power Station was not operational and again in January 2016 when Keadby 1 Power Station was operational.

9.4.2 The L_{Aeq} values presented in Table 9.15 combine all measurements taken in each time period (e.g. day/night), whilst the L_{AF90} values presented are the 'representative' BS 4142 *background sound levels*, determined from analysis of the measured values undertaken for the Keadby 2 Power Station ES.

Table 9.15: Baseline sound levels (using representative data from Keadby 2 Power Station ES)

Receptor	Time period	Summer 2015 survey (without Keadby 1 Power Station operating)		January 2016 survey (with Keadby 1 Power Station operating)	
		$L_{Aeq,T}$ dB	$L_{AF90,15min}$ dB	$L_{Aeq,T}$ dB	$L_{AF90,15min}$ dB
NSR 1 - Vazon Bridge	Daytime	59	37	58	39
	Night-time	39 (periods without trains) 59 (periods with trains)	36	39 (periods without trains) 60 (periods with trains)	38
NSR 1A - Roe Farm**	Daytime	59	37	58	39
	Night-time	39 (periods without trains) 59 (periods with trains)	36	39 (periods without trains) 60 (periods with trains)	38
NSR 2 - Hawthorne House, Chapel Lane	Daytime	45	37	45	39
	Night-time	36	33	41	40
NSR 3 - Keadby Village	Daytime	45	35	44	39
	Night-time	36	30	41	38
NSR 4 - Mariners Arms Flats	Daytime	45	35*	44	39
	Night-time	36	30*	41	38
NSR 5 - Trent Side	Daytime	45	35*	44*	39
	Night-time	36	30*	41*	38
NSR 6 - 9 Queens Crescent	Daytime	45	35*	44*	39
	Night-time	36	30*	41*	38
NSR 7 - Keadby Grange	Daytime	45#	35*	44#	39*
	Night-time	36#	30*	41#	38*
	Daytime	45#	35*	44#	39*

Receptor	Time period	Summer 2015 survey (without Keadby 1 Power Station operating)		January 2016 survey (with Keadby 1 Power Station operating)	
		$L_{Aeq,T}$ dB	$L_{AF90,15min}$ dB	$L_{Aeq,T}$ dB	$L_{AF90,15min}$ dB
NSR 8 - North Pilfrey Farm	Night-time	36#	30*	41#	38*
NSR 9 - Ealand Poultry Farm	Daytime	45#	35*	44#	39*
	Night-time	36#	30*	41#	38*
NSR 10 - North Moor Farm	Daytime	45#	35*	44#	39*
	Night-time	36#	30*	41#	38*
NSR 11 - South Pilfrey Farm	Daytime	45#	35*	44#	39*
	Night-time	36#	30*	41#	38*

* Keadby Village data used as measurements were not undertaken at these locations in Keadby 2 Power Station ES.

Lowest measured levels from Keadby 2 Power Station ES used in proxy of representative baseline sound survey data being available due to COVID-19 restrictions, to enable this NSR to be incorporated into the assessment.

**Roe Farm is 70m approx. from Vazon Bridge so the same baseline data have been used.

9.4.3 The observations shown in Table 9.16 are taken from the Keadby 2 Power Station ES regarding the general baseline sound environment at each monitoring location.

Table 9.16: Receptor noise climate observations

Receptor	Noise climate observations
NSR 1 - Vazon Bridge (also considered representative of NSR 1A – Roe Farm)	*"Passing trains exhibit high levels of noise for a short period with L_{Amax} levels in the range 75-85dB, but they have little effect on the background L_{90} levels. Consequently, during the day, the noise climate at Vazon Bridge House is dynamic, with L_{eq} levels approximately 59dB and L_{90} levels 37dB. This pattern continues at night except between about 0100 and 0400 at weekends and on some weekdays when there are no trains and L_{eq} noise levels drop. This dynamic noise environment is important to the noise assessment because it influences the way in which new noise from the power station will be perceived. Importantly the railway lies between the house and the power plant site, so the rooms that will experience new noise from the extended power station are the same rooms that currently experience train noise levels of L_{Amax} 75-85dB at least four times an hour, 21 hours a day. It is reasonable to assume that the occupiers of the house cope with these levels of train noise day and night, and as a consequence are considerably less likely to be affected by an increase in background noise than if there was no train noise present."* As NSR 1A Roe Farm is only 70 m from Vazon Bridge, it is considered likely, given the surrounding land uses, to have a very similar sound environment.
NSR 2 - Hawthorne House, Chapel Lane	*"(Red House) is situated on the north-east corner of Chapel Lane. Noise from trains is also audible here with industrial noise sources and some noise from wind turbines creating a less dynamic noise climate than NSR1. During the January 2016 survey, noise from Keadby I operating was audible and contributing to the noise levels."* *"(NSR 2) is on Chapel Lane. The noise climate is similar to Red House."*
NSR 3 - Keadby Village	*"… is 45A Chapel Lane, approximately 30 metres North-east of Keadby water tower. During the day, noise from people in the village elevates L_{eq} levels above background but at night these sources drop away to a less dynamic environment. During the January 2016 survey noise from Keadby I operating was audible and contributing to the noise levels."* In this ES a different NSR 3 has been selected to represent Keadby Village at 74 Chapel Lane as this location was closer to the Main Site. This is approximately 150m from

Receptor	Noise climate observations
	45A Chapel, although is likely to comprise a similar baseline sound environment.
NSR 4 - Mariners Arms Flats	*"(NSR 4) is Mariners Arms Flats terrace. The noise climate in this location is similar at NML4* (NSR 3)*, both being near Keadby Village."*
NSR 5 - Trent Side	*"Trent Side (NSR 5) and South Bank … are located on the roads Trent Side and South Bank respectively. The noise levels are similar to those at Keadby Village and Mariners Arms Flats."*
NSR 6 - 9 Queens Crescent (South Bank data)	*"Trent Side (NSR 5) and South Bank … are located on the roads Trent Side and South Bank respectively. The noise levels are similar to those at Keadby Village and Mariners Arms Flats."* In this ES a different NSR 6 has been selected to represent the properties on the south bank of Three Rivers at 9 Queens Crescent, as this location is closer to the Keadby 3 Main Site. This is approximately 100 m from South Bank, although is likely to comprise a similar baseline sound environment.
NSR 7 - Keadby Grange	No observations available from the Keadby 2 Power Station ES. However, the railway line is 450 m away and so likely to be audible intermittently, and the A18 and distant M180 are likely to be sources of sound contributing to the *ambient* and *background sound levels*.
NSR 8 - North Pilfrey Farm	No observations available from the Keadby 2 Power Station ES. However, the NSR is approximately 40 m from the railway line therefore likely to have a similar character to the baseline sound environment at Vazon Bridge, albeit with a different level of sound contribution from Keadby 1 Power Station.
NSR 9 - Ealand Poultry Farm	No observations available from the Keadby 2 Power Station ES. Likely to be a combination of commercial/industrial, residential, transportation sound sources.
NSR 10 - North Moor Farm	No observations available from the Keadby 2 Power Station ES. Likely to be a combination of distant industrial and transportation sound sources.

Receptor	Noise climate observations
NSR 11 - South Pilfrey Farm	No observations available from the Keadby 2 Power Station ES. Likely to be a combination of distant industrial and transportation sound sources particularly from the A18.

9.4.4 In the January 2016, baseline sound survey undertaken with Keadby 1 Power Station operating, higher *background sound levels* ($L_{A90,T}$) were measured in the daytime (2-4 dB higher) and in the night-time (2-8 dB) higher when compared to the 2015 survey. Daytime *ambient sound levels* ($L_{Aeq,T}$) at all NSR were within 1 dB of the 2015 survey data and at night were the same at NSR 1 but 5 dB higher at other NSR.

Covid-19 Pandemic

9.4.5 As previously set out, in the light of the ongoing Covid-19 pandemic and associated lockdowns and travel restrictions during 2020/2021, it was agreed with NLC that the Keadby 2 Power Station ES data would be considered representative and used for the purposes of this assessment.

9.4.6 It is proposed that additional baseline sound level data will be collected at the detailed design stage as described in Section 9.7.

Future Baseline

9.4.7 In 2022, construction and commissioning of Keadby 2 Power Station is expected to be complete and it will become operational. Condition 28 of the final Section 36 consent (BEIS, 2019) for Keadby 2 Power Station relates to control of noise:

28) Notwithstanding the noise levels approved by the Borough Council pursuant to Condition (27) the noise levels when measured at one metre in front of the nearest residential properties in Chapel Lane, Trentside and the Mariners Arms, Keadby shall be within 5 dB(A) of the ambient noise levels approved pursuant to Condition (25) as assessed by British Standard 4142 and exhibit no tonal content, except at the Vazon Bridge dwelling where the plant should not exceed $L_{Aeq,T}$ 50dB free-field, while also exhibiting no tonal content.

9.4.8 Taking into consideration these consent limits, an increase in *background* and *ambient sound levels* in the vicinity of the Proposed Development Site may occur in the short-term once Keadby 2 Power Station becomes operational. To account for this increase in the assessment of operational noise for the Proposed Development, adjustments to the measured *background sound level* have been made, based upon predicted sound levels from Keadby 2 Power Station. This is shown later in Table 9.30.

9.4.9 Keadby 1 Power Station has a contract to provide capacity to the grid until September 2022 and will have opportunities to secure further agreements in

future auctions. It is recognised that Keadby 1 Power Station will not run concurrently with the Proposed Development as described in **Chapter 2**: Assessment Methodology (ES Volume I – **Application Document Ref. 6.2**). However, as part of the future baseline, structures associated with Keadby 1 Power Station are assumed to continue to be present on-site. Future baseline *ambient* and *background sound levels* may change (reduce) at NSR in the vicinity of the Keadby 1 Power Station, although uncertainty regarding this has precluded this from further assessment.

9.4.10 In the absence of the Proposed Development, future baseline sound levels at NSR will continue to be influenced by traffic flows on surrounding road and rail networks, and the future operations at other industrial and commercial premises in the area.

9.5 Development Design and Impact Avoidance

Construction noise

9.5.1 Core construction working hours would be 07:00 to 19:00 Monday to Friday and Saturday (08:00 to 13:00). As described in **Chapter 5**: Construction Programme and Management (ES Volume I – **Application Document Ref. 6.2**), core working hours associated with installation of any cofferdam required for the River Water and Canal Water Abstraction Options would be restricted to daytime hours only. However, for other construction activities, it is assumed that some works may need to take place outside of these core working hours and would be undertaken providing that they comply with any restrictions agreed with the local planning authority, in particular regarding control of noise and traffic.

9.5.2 Measures to mitigate noise will be implemented during the construction phase of the Proposed Development in order to minimise impacts at local NSR and ecological receptors, particularly with respect to activities required outside of core working hours. Mitigation (to be included in the final CEMP) and as outlined in the Framework CEMP (**Application Document Ref. 7.1**) shall include, but not be limited to:

- abiding by agreed construction noise limits at locations to be agreed with NLC;
- ensuring that processes are in place to minimise noise before works begin and ensuring that BPM are being achieved throughout the construction programme, including the use of localised screening around significant noise producing plant and activities;
- ensuring that modern plant is used, complying with applicable UK noise emission requirements, and selection of inherently quiet plant where possible;
- hydraulic techniques for breaking to be used, where practical, in preference to percussive techniques where reasonably practicable;

- use of lower noise piling (e.g. rotary bored or hydraulic jacking) rather than driven piling techniques, where reasonably practicable;
- off-site pre-fabrication for components of the Proposed Development, where reasonably practicable;
- all plant and equipment being used for the works to be properly maintained, silenced where appropriate, operated to prevent excessive noise and switched off when not in use;
- all contractors to be made familiar with current legislation and the guidance in BS 5228 (Parts 1 and 2) (BSI, 2014a and b), which should form a prerequisite of their appointment;
- loading and unloading of vehicles, dismantling of site equipment such as scaffolding or moving equipment or materials within the Proposed Development Site to be conducted in such a manner as to minimise noise generation, as far as reasonably practicable;
- appropriate routing of construction traffic on public roads and along access tracks, to reduce construction traffic noise, as far as reasonably practicable (see **Chapter 10**: Traffic and Transportation (ES Volume I – **Application Document Ref. 6.2**));
- provision of information to NLC and local residents to advise of potential noisy works that are due to take place; and
- monitoring of noise complaints and reporting to the Applicant for immediate investigation.

9.5.3 Method statements regarding construction management, traffic management, and overall site management will be prepared in accordance with best practice and relevant British Standards, to help to reduce impacts of construction works. One of the key aims of such method statements will be to minimise noise disruption to local residents during the construction phase as far as reasonably practicable.

9.5.4 Regular communication with the local community throughout the construction period will also serve to publicise the works schedule, giving notification to residents regarding periods when higher levels of noise may occur during specific operations, and providing lines of communication where complaints can be addressed.

9.5.5 The selected contractor would be encouraged to be a member of the 'Considerate Constructors Scheme', which is an initiative open to all contractors undertaking building work.

9.5.6 As mentioned above, a final CEMP will be prepared which will include setting out provisions to ensure that the noise and vibration impacts relating to construction activities are reduced, as far as reasonably practicable, based on the measures outlined above. A framework CEMP accompanies the DCO application (**Application Document Ref. 7.1**).

9.5.7 To assist in the preparation of the final CEMP, a detailed noise and vibration assessment will be undertaken once the contractor is appointed and further details of construction methods are known in order to identify specific mitigation measures for the Proposed Development (including construction traffic).

9.5.8 The timing details of decommissioning are uncertain at this time. However, the mitigation measures set out in this Section for construction noise will also be appropriate mitigation during the decommissioning stage.

9.5.9 The control and monitoring of noise during construction and decommissioning is proposed to be secured by a Requirement of the draft DCO (**Application Document Ref. 2.1**).

9.5.10 Measures to mitigate noise associated with any carbon dioxide venting during commissioning will include those listed above for construction.

9.5.11 As carbon dioxide venting during operation would only take place during emergency scenarios, it is not considered that any further consideration of effects or potential mitigation is required within this noise assessment.

Construction Vibration

9.5.12 Should the River Water Abstraction Option be selected requiring that construction works, including a cofferdam installation/ removal take place at locations close to, or within, the River Trent SPA/ Ramsar site/ SSSI, vibration impacts on ecological receptors would be minimised by applying:

- standard mitigation for impact piling in marine waters (JNCC, 2010) which includes soft-start or slow ramp-up of piling hammer power at the commencement of any impact piling activity or after a break of more than 10 minutes, as described in **Chapter 5**: Construction Programme and Management (ES Volume I – **Application Document Ref. 6.2**) and which will be secured via the deemed Marine Licence (DML) which is included within the draft DCO (**Application Document Ref. 2.1**); and
- installation and removal of the cofferdam including piling will be restricted to the construction working hours of 07:00 to 19:00 (**Chapter 5**: Construction Programme and Management (ES Volume I – **Application Document Ref. 6.2**) which will mean that these works are largely restricted to daylight hours further reducing potential for impacts on migratory fish which migrate in hours of darkness.

9.5.13 Restriction of piling to daytime working hours would also mean that residential NSR would be similarly unaffected outside of these core working hours.

9.5.14 Regular communication with the local community throughout the cofferdam installation/ removal will also serve to publicise the works schedule, giving notification to residents regarding periods when vibration may occur during specific operations and providing lines of communication should there be any concerns.

Operational Noise and Vibration

9.5.15 During the detailed design stage, potential significant residual noise effects will be mitigated by location and design (see Section 9.7). This will include appropriate stack design, use of cladding and shielding where appropriate and, where practical siting of equipment away from site boundaries and NSR.

9.5.16 The control and monitoring of noise during operation is proposed to be secured by a Requirement of the draft DCO (**Application Document Ref. 2.1**).

9.5.17 The Proposed PCC Site will be operated in accordance with an Environmental Permit, issued and regulated by the Environment Agency. This will require operational noise from the generating station to be controlled through the use of BAT, which will be determined through the Environmental Permit application. It is proposed that operational noise limits will also be secured by a Requirement of the draft DCO (**Application Document Ref. 2.1**).

Decommissioning

9.5.18 Appropriate best practice mitigation measures will be applied during any decommissioning works and documented in a Decommissioning Environmental Management Plan (DEMP) to control noise effects. This is proposed to be secured by a Requirement in the draft DCO (**Application Document Ref. 2.1**). No additional mitigation for decommissioning of the Proposed Development beyond such best practice is considered necessary at this stage. .

9.6 Likely Impacts and Effects

Construction Noise and Vibration Effects

9.6.1 Based upon the analysis and summary of the results of the existing free-field baseline ambient sound surveys undertaken for the Keadby 2 Power Station ES, Table 9.17 sets out the BS 5228 'ABC' noise threshold categories (BSI, 2014) at each NSR for the day, evening and night-time periods as set out in Table 9.7.

Table 9.17: Measured free-field $L_{Aeq,T}$ noise levels and associated "ABC" assessment category

Receptor	Weekday daytime 07:00 – 19:00		Weekday evening 19:00 – 23:00		Night-time 23:00 – 07:00	
	$L_{Aeq,T}$ dB	ABC	$L_{Aeq,T}$ dB	ABC	$L_{Aeq,T}$ dB	ABC
NSR 1 - Vazon Bridge	59	A	59	C	39/59*	A/C
NSR 1A - Roe Farm	**59**	**A**	**59**	**C**	**39/59***	**A/C**

Receptor	Weekday daytime 07:00 – 19:00		Weekday evening 19:00 – 23:00		Night-time 23:00 – 07:00	
	$L_{Aeq,T}$ dB	ABC	$L_{Aeq,T}$ dB	ABC	$L_{Aeq,T}$ dB	ABC
NSR 2 - Hawthorne House, Chapel Lane	45	A	41	A	36	A
NSR 3 - Keadby Village	45	A	45	A	36	A
NSR 4 - Mariners Arms Flats	45	A	45	A	36	A
NSR 5 - Trent Side	45	A	45	A	36	A
NSR 6 - 9 Queens Crescent (South Bank data)	45	A	45	A	36	A
NSR 7 - Keadby Grange	45	A	41	A	36	A
NSR 8 - North Pilfrey Farm	45	A	41	A	36	A
NSR 9 - Ealand Poultry Farm	45	A	41	A	36	A
NSR 10 - North Moor Farm	45	A	41	A	36	A
NSR 11 - South Pilfrey Farm	45	A	41	A	36	A
*This is the value for periods without/ with trains on the nearby Scunthorpe to Doncaster passenger railway line. Both are used in assessment of construction noise effects.						

9.6.2 Construction noise limits have been derived for each NSR in Table 9.18 below using the BS 5228 ABC methodology (described in Table 9.6). Where baseline sound level data are not available for an NSR, limits have been assigned using conservative assumptions including:

- assuming the lowest measured sound level for the given time period from other representative measurement locations; and
- assuming indicative weekend noise limits based upon the most conservative Category A values.

Table 9.18: Indicative construction noise limits / SOAEL values

Receptor	Construction noise limit $L_{Aeq,T}$ dB (free-field) / SOAEL values					
	Weekday daytime 07:00 – 19:00	Weekday evening 19:00 – 23:00	Night 23:00 – 07:00	Saturday 07:00 – 13:00	Saturday 13:00 – 23:00	Sunday 07:00 – 23:00
NSR 1 - Vazon Bridge	65	65	45/55	65	55	55
NSR 1A - Roe Farm	65	65	45/55	65	55	55
NSR 2 - Hawthorne House, Chapel Lane	65	55	45	65	55	55
NSR 3 - Keadby Village	65	55	45	65	55	55
NSR 4 - Mariners Arms Flats	65	55	45	65	55	55
NSR 5 - Trent Side	65	55	45	65	55	55
NSR 6 - 9 Queens Crescent (South Bank data)	65	55	45	65	55	55
NSR 7 - Keadby Grange	65	55	45	65	55	55
NSR 8 - North Pilfrey Farm	65	55	45	65	55	55
NSR 9 - Ealand Poultry Farm	65	55	45	65	55	55

Receptor	Construction noise limit $L_{Aeq,T}$ dB (free-field) / SOAEL values					
	Weekday daytime 07:00 – 19:00	Weekday evening 19:00 – 23:00	Night 23:00 – 07:00	Saturday 07:00 – 13:00	Saturday 13:00 – 23:00	Sunday 07:00 – 23:00
NSR 10 - North Moor Farm	65	55	45	65	55	55
NSR 11 - South Pilfrey Farm	65	55	45	65	55	55

Construction noise predictions

9.6.3 This Section discusses the potential noise and vibration effects on NSR arising during the construction phase of the Proposed Development. Noise effects are assessed for the construction of:

- the Proposed PCC site;
- Electrical Connection to 132kV Northern Powergrid Substation option;
- River Water Abstraction and Canal Water Abstraction Options; and
- A18/ Mabey Bridge replacement.

9.6.4 Noise levels experienced by local NSR during such works depend upon several variables, the most significant of which are:

- the noise generated by plant or equipment used on site, generally expressed as sound power levels (L_w) or the vibration generated by the plant;
- the periods of use of the plant on site, known as its on-time;
- the distance between the noise/ vibration source and the receptor;
- the noise attenuation due to ground absorption, air absorption and barrier effects;
- in some instances, the reflection of noise due to the presence of hard surfaces such as the sides of buildings; and
- the time of day or night the works are undertaken.

9.6.5 The construction noise predictions have been undertaken using noise data for plant items and calculation methodologies from BS 5228 (2014a). For the construction of the Proposed PCC site, fixed plant has been assumed to be evenly distributed through the Main Site. Mobile plant has been assumed to be

evenly distributed within the Main Site as well as the Construction Laydown Areas shown on **Figure 5.1** (ES Volume III - **Application Document Ref. 6.4**)).

9.6.6 Construction will also take place in the Electrical Connection to the 132kV Substation, Water Connection Corridors and at the A18/ Mabey Bridge. For these areas, construction is been assumed to be undertaken at the closest point within the Corridor to the NSR.

9.6.7 As described in **Chapter 4**: The Proposed Development (ES Volume I – **Application Document Ref. 6.2**) construction of the Proposed Development could (subject to the necessary consents being granted and an investment decision being made) potentially start as early as Quarter 4 2022 when it is anticipated the consent would be granted. However, due to the period over which consent is being sought (seven years), construction could start in 2029 and continue until 2031.

9.6.8 The Applicant would appoint one or more contractors for the construction of the CCGT and CCP. Additional contractors are likely to be appointed to undertake the proposed minor highway works. An early works phase, including the A18 carriageway improvements and Mabey Bridge replacement, would be undertaken over a circa 6 month period. Construction activities for the main works phase are expected to be completed within approximately three years, followed by commissioning.

9.6.9 Core construction working hours would be 07:00 to 19:00 Monday to Friday and Saturday (08:00 to 13:00). As described in **Chapter 5**: Construction Programme and Management (ES Volume I – **Application Document Ref. 6.2**), it is assumed that some works may need to take place outside of these core working hours and would be undertaken providing that they comply with any restrictions agreed with the local planning authority, in particular regarding control of noise and traffic.

9.6.10 Due to the early stage of project design, indicative predicted noise levels for construction of the Proposed Development have been based on construction methods used for similar power stations in the UK. This gives an indication of where, at what stage and during which construction activities construction noise is at risk of leading to potentially adverse and significant adverse effects by comparison with construction noise LOAEL and SOAEL for each residential NSR.

9.6.11 The predicted levels apply to core weekday daytime (07:00 – 19:00) working, although could approximate to other time periods where working at the same rate and intensity is proposed. These assume constant operation of equipment throughout the 07:00 – 19:00 periods which is a conservative worst-case assumption. Details regarding the noise prediction methodology, including a full list of indicative construction plant and associated sound power levels (L_w) for each construction phase, are presented in **Appendix 9A**: Construction Noise Assessment Methodology (ES Volume II – **Application Document Ref. 6.3**).

9.6.12 A summary of indicative noise predictions at the NSR locations for construction activities associated with the Proposed PCC Site (i.e. CCGT and CCP/ associated development) are presented in Table 9.19.

9.6.13 As advised by BS 5228, noise levels predicted at distances over 300m should be treated with caution due to the increasing importance of meteorological effects. There are no NSR within 300m of the Main Site. The closest NSR to construction activities at the Main Site is NSR 1A – Roe Farm at approximately 400m from the Main Site.

Table 9.19: Indicative free-field construction noise levels during daytime Proposed PCC Site construction activity

Receptor	Indicative free-field construction noise levels during daytime construction activity (dB $L_{Aeq,12h}$)		
	Site enabling and preparation	Main civil works (including piling and foundations)	Plant installation
NSR 1 - Vazon Bridge	57	60	55
NSR 1A - Roe Farm	60	63	57
NSR 2 - Hawthorne House, Chapel Lane	49	52	47
NSR 3 - Keadby Village	44	48	44
NSR 4 - Mariners Arms Flats	41	45	42
NSR 5 - Trent Side	41	45	41
NSR 6 - 9 Queens Crescent (South Bank data)	40	44	40
NSR 7 - Keadby Grange	46	50	45
NSR 8 - North Pilfrey Farm	51	54	48
NSR 9 - Ealand Poultry Farm	40	44	40
NSR 10 - North Moor Farm	48	52	47
Values above the daytime threshold (and SOAEL) of 65 dB $L_{Aeq,12h}$ are shown in bold			

9.6.14 An option to connect the Proposed Development into the existing Northern Powergrid 132 kV Substation on Chapel Lane to supply power to the Proposed PCC Site plant and equipment during start-up is under consideration. There are

two possible routes for an underground cable (refer to **Figure 3.3** in ES Volume III - **Application Document Ref. 6.4**). For the purposes of worst-case predictions, construction activities have been assumed at the closest point to either of these potential connection routes when undertaking predictions at each NSR. As it is likely that cabling would be primarily below ground, predictions have been made for topsoil striping as the potentially most significant noise source during this activity. Noise predictions are shown in Table 9.20.

Table 9.20: Indicative construction noise predictions for 132kV electrical connection construction

Receptor	Indicative free-field construction noise levels during daytime electrical connection construction activity (dB $L_{Aeq,12h}$)
NSR 1 - Vazon Bridge	56
NSR 1A - Roe Farm	56
NSR 2 - Hawthorne House, Chapel Lane	59
NSR 3 - Keadby Village	49
NSR 4 - Mariners Arms Flats	51
NSR 5 - Trent Side	51
NSR 6 - 9 Queens Crescent (South Bank data)	50
NSR 7 - Keadby Grange	46
NSR 8 - North Pilfrey Farm	49
NSR 9 - Ealand Poultry Farm	36
NSR 10 - North Moor Farm	53
Values above the daytime threshold (and SOAEL) of 65 dB $L_{Aeq,12h}$ are shown in bold	

9.6.15 Within the Water Connection Corridor, construction of a water abstraction and discharge point will be required. Two options are currently under consideration for the cooling water abstraction – either a preferred abstraction from the Stainforth and Keadby Canal, or if this is not feasible, utilising/ upgrading the existing abstraction infrastructure for Keadby 1 Power Station within the River Trent.

9.6.16 If the River Water Abstraction Corridor is selected, some of the existing pipework may be able to be re-used but this will need to be extended to the Proposed PCC Site. If upgrade works to existing sections of buried pipelines are required, trenchless excavation techniques 'sliplining' would be used as described in **Chapter 5**: Construction Programme and Management (ES

Volume I – **Application Document Ref. 6.2**) and as such, it is envisaged that these works will be relatively minor.

9.6.17 If the preferred Canal Water Abstraction Option is selected, new pipework would be installed adjacent to the Keadby 2 Power Station intake structure and pipework extended across the Keadby 2 Power Station footprint and across Chapel Lane towards the Proposed PCC Site.

9.6.18 The water discharge corridor will make use of an existing outfall and associated pipework and therefore it is not considered likely that any significant effects could result.

9.6.19 Installation of a cofferdam would be required at either of the abstraction options and it is this activity that would be expected to produce the highest noise levels at the NSR during the construction works within the Water Connection Corridor. Noise levels at NSR resulting from installation of the cofferdam have been predicted using sheet piling, as this activity would be expected to result in the highest noise levels during cofferdam installation and removal. Construction has been assumed to be through the full working day, as a conservative assumption. Noise predictions are shown in Table 9.21.

Table 9.21: Indicative construction noise predictions for Water Connection Corridor (cofferdam activity) construction

Receptor	Indicative free-field construction noise level for daytime water connection construction activity (dB $L_{Aeq,12h}$)	Indicative free-field construction noise level for daytime water connection construction activity (dB $L_{Aeq,12h}$)
	River Water Abstraction Option	**Canal Water Abstraction Option**
NSR 1 - Vazon Bridge	42	64
NSR 1A - Roe Farm	41	62
NSR 2 - Hawthorne House, Chapel Lane	47	47
NSR 3 - Keadby Village	53	48
NSR 4 - Mariners Arms Flats	**66-75 (82*)**	48
NSR 5 - Trent Side	56	47
NSR 6 - 9 Queens Crescent (South Bank data)	49	52
NSR 7 - Keadby Grange	36	42
NSR 8 - North Pilfrey Farm	30	34
NSR 9 - Ealand Poultry Farm	27	30
NSR 10 - North Moor Farm	40	45

Values above the daytime threshold (and SOAEL) of 65 dB $L_{Aeq,12h}$ are shown in bold

*As NSR 4 is a receptor group very close to installation of the cofferdam a range of construction noise levels (66-75 dB $L_{Aeq,12h}$) are predicted to be experienced within the group with the highest at the Mariners Arms Flats closest to the river and the lowest at the Mariners Arms Flats furthest from the river. Separately, up to 82 dB $L_{Aeq,12h}$ is predicted at Blacksmiths Cottage and 19 Trentside, which are also located within the vicinity of this group of NSR but are closer to the cofferdam works.

9.6.20 The Proposed Development will include the maintenance and improvement of an existing private access road from the junction with the A18, including a slight widening of this junction to provide a right-turn lane and the replacement of a private bridge (Mabey Bridge). Within these activities, it is assumed that replacement of Mabey Bridge will require continuous flight auger piling which is expected to be the highest noise activity during this early works phase. Therefore, predictions have been made of noise levels at NSR resulting from continuous flight auger piling, providing worst-case predictions for construction activities in this area. Construction has been assumed to be through the full working day, as a conservative assumption. Noise predictions are shown in Table 9.22.

Table 9.22: Indicative construction noise predictions for Mabey Bridge replacement

Receptor	Indicative free-field daytime construction noise levels for Mabey Bridge construction activity (dB $L_{Aeq,12h}$)
NSR 7 - Keadby Grange	45
NSR 8 - North Pilfrey Farm	45
NSR 11 - South Pilfrey Farm	55
Values above the daytime threshold (and SOAEL) of 65 dB $L_{Aeq,12h}$ are shown in bold Only the key receptors of NSR 7, NSR 8 and NSR 11 are included in this table. Where an NSR is significantly further from the construction area than the closest NSR, significant noise effects are not likely if noise levels are suitably controlled at the closer key representative receptors.	

Noise effects of Proposed PCC Site construction

9.6.21 The predicted daytime construction noise levels (as presented in Table 9.19) have been assumed as a conservative approach to be equivalent to weekday daytime, evening and night-time noise levels. The predicted effects during each time period have been classified by considering the relevant ABC noise limit values given in Table 9.18, and using the semantic scales in Table 9.7, Table 9.13 and Table 9.14. These effects are summarised in Table 9.23.

Table 9.23: Indicative construction noise effects of Proposed PCC Site construction for works required

Receptor	Time period	Proposed PCC site construction – significance of effects		
		Site enabling and preparation	**Main civil works (including piling and foundations)**	**Plant installation**
NSR 1 - Vazon Bridge	Daytime	Negligible adverse	Negligible adverse	Negligible adverse
	Evening	Negligible adverse	Negligible adverse	Negligible adverse
	Night-time	**Moderate adverse/ Major adverse ***	**Major adverse/ Major adverse ***	Minor adverse **/ Major adverse ***
NSR 1A - Roe Farm	Daytime	Negligible adverse	Minor adverse	Negligible adverse
	Evening	Negligible adverse	Minor adverse	Negligible adverse
	Night-time	**Major adverse / Major adverse ***	**Major adverse/ Major adverse ***	**Moderate adverse/ Major adverse***
NSR 2 - Hawthorne House	Daytime	Negligible adverse	Negligible adverse	Negligible adverse
	Evening	Negligible adverse	Minor adverse	Negligible adverse
	Night-time	**Moderate adverse**	**Major adverse**	**Moderate adverse**
NSR 3 - Keadby Village	Daytime	Negligible adverse	Negligible adverse	Negligible adverse
	Evening	Negligible adverse	Negligible adverse	Negligible adverse
	Night-time	Minor adverse	**Moderate adverse**	Minor adverse
NSR 4 - Mariners Arms Flats	Daytime	Negligible adverse	Negligible adverse	Negligible adverse
	Evening	Negligible adverse	Negligible adverse	Negligible adverse

Receptor	Time period	Proposed PCC site construction – significance of effects		
		Site enabling and preparation	**Main civil works (including piling and foundations)**	**Plant installation**
	Night-time	Minor adverse	Minor adverse	Minor adverse
NSR 5 - Trent Side	Daytime	Negligible adverse	Negligible adverse	Negligible adverse
	Evening	Negligible adverse	Negligible adverse	Negligible adverse
	Night-time	Minor adverse	Minor adverse	Minor adverse
NSR 6 - 9 Queens Crescent (South Bank data)	Daytime	Negligible adverse	Negligible adverse	Negligible adverse
	Evening	Negligible adverse	Negligible adverse	Negligible adverse
	Night-time	Negligible adverse	Minor adverse	Negligible adverse
NSR 7 - Keadby Grange	Daytime	Negligible adverse	Negligible adverse	Negligible adverse
	Evening	Negligible adverse	Minor adverse	Negligible adverse
	Night-time	**Moderate adverse**	**Major adverse**	Minor adverse
NSR 8 - North Pilfrey Farm	Daytime	Negligible adverse	Negligible adverse	Negligible adverse
	Evening	Minor adverse	Minor adverse	Negligible adverse
	Night-time	**Major adverse**	**Major adverse**	**Moderate adverse**
	Daytime	Negligible adverse	Negligible adverse	Negligible adverse

Receptor	Time period	Proposed PCC site construction – significance of effects		
		Site enabling and preparation	**Main civil works (including piling and foundations)**	**Plant installation**
NSR 9 - Ealand Poultry Farm	Evening	Negligible adverse	Negligible adverse	Negligible adverse
	Night-time	Negligible adverse	Minor adverse	Negligible adverse
NSR 10 - North Moor Farm	Daytime	Negligible adverse	Negligible adverse	Negligible adverse
	Evening	Negligible adverse	Minor adverse	Negligible adverse
	Night-time	**Moderate adverse**	**Major adverse**	**Moderate adverse**
Daytime (07:00 – 19:00 weekdays) also represents Saturday mornings (07:00 – 13:00) Evening (19:00 – 23:00 weekdays) also represents Saturday afternoons (13:00 – 23:00) and Sundays (07:00 – 23:00) Night-time (23:00 – 07:00 all week) Potentially significant effects are in bold *At NSR 1 and NSR 1A during the night-time, the significance of effect assigned is based upon the ambient sound levels without/with train passbys on the nearby railway line				

9.6.22 Construction noise effects at all residential NSR during construction of the Proposed PCC Site within core daytime hours including Saturday mornings are predicted to be minor adverse/ negligible (**not significant**) due largely to the distances between the works and NSR.

9.6.23 It may be necessary for some construction activities to take place continuously over day, evening and night periods during peak construction times of the Proposed Development, although the exact nature of the works is unknown at this stage. Construction noise threshold values (SOAEL values) during non-weekday daytime periods have been defined in Table 9.6.

9.6.24 Comparison of the predicted daytime noise levels for construction of the Proposed PCC Site against the lower limit values for the evening, Saturday afternoon and Sunday all day periods indicate the potential for up to minor adverse (**not significant**) effects if the same intensity of working as for the daytime is assumed. During night-time, the potential for moderate/ major adverse (**significant**) effects is predicted at seven of the 11 NSR during at least one construction phase if the same intensity of working as for the daytime is assumed.

Noise effects of electrical connection construction

9.6.25 The predicted effects of the electrical connection construction noise levels are shown in Table 9.24.

Table 9.24: Indicative construction noise effects of electrical connection to 132kv substation option

Receptor	**Electrical connection construction – significance of effects**		
	Daytime	**Evening**	**Night-time**
NSR 1 - Vazon Bridge	Negligible adverse	Negligible adverse	**Moderate/ Major adverse**
NSR 1A - Roe Farm	Negligible adverse	Negligible adverse	**Moderate/ Major adverse** *
NSR 2 - Hawthorne House, Chapel Lane	Negligible adverse	**Moderate adverse**	**Major adverse**
NSR 3 - Keadby Village	Negligible adverse	Negligible adverse	**Moderate adverse**
NSR 4 - Mariners Arms Flats	Negligible adverse	Minor adverse	**Major adverse**
NSR 5 - Trent Side	Negligible adverse	Minor adverse	**Major adverse**

Receptor	Electrical connection construction – significance of effects		
	Daytime	**Evening**	**Night-time**
NSR 6 - 9 Queens Crescent (South Bank data)	Negligible adverse	Minor adverse	**Major adverse**
NSR 7 - Keadby Grange	Negligible adverse	Negligible adverse	**Moderate adverse**
NSR 8 - North Pilfrey Farm	Negligible adverse	Negligible adverse	**Moderate adverse**
NSR 9 - Ealand Poultry Farm	Negligible adverse	Negligible adverse	Negligible adverse
NSR 10 - North Moor Farm	Negligible adverse	Minor adverse	**Major adverse**
Daytime (07:00 – 19:00 weekdays) also represents Saturday mornings (07:00 – 13:00) Evening (19:00 – 23:00 weekdays) also represents Saturday afternoons (13:00 – 23:00) and Sundays (07:00 – 23:00) Night-time (23:00 – 07:00 all week) Potentially significant effects are in bold *At NSR 1 during the night-time, the significance of effect assigned is based upon the ambient sound levels without/with train passbys on the nearby railway line			

9.6.26 During the core daytime hours and Saturday mornings, predicted noise effects during topsoil stripping for laying the cable to the existing Northern Powergrid 132 kV Substation are assessed as negligible adverse (**not significant**) at all NSR. Should it be necessary to undertake works in the evening or other weekend periods at the same intensity as daytime works, moderate effects (**significant**) are predicted at one of the 11 NSR, and at night, moderate or major adverse (**significant**) effects are predicted at 10 of the 11 NSR.

Noise effects of water connection construction

9.6.27 The effects of the predicted water connection construction noise levels are shown in Table 9.25. It has been confirmed cofferdam installation will only take place during the daytime so only daytime effects are presented.

Table 9.25: Indicative daytime Water Connection Corridor construction noise effects

Receptor	River Water Abstraction Option	Canal Water Abstraction Option
NSR 1 - Vazon Bridge	Negligible adverse	Minor adverse

Receptor	River Water Abstraction Option	Canal Water Abstraction Option
NSR 1A - Roe Farm	Negligible adverse	Minor adverse
NSR 2 - Hawthorne House, Chapel Lane	Negligible adverse	Negligible adverse
NSR 3 - Keadby Village	Negligible adverse	Negligible adverse
NSR 4 - Mariners Arms Flats	**Moderate/ Major adverse**	Negligible adverse
NSR 5 - Trent Side	Negligible adverse	Negligible adverse
NSR 6 - 9 Queens Crescent (South Bank data)	Negligible adverse	Negligible adverse
NSR 7 - Keadby Grange	Negligible adverse	Negligible adverse
NSR 8 - North Pilfrey Farm	Negligible adverse	Negligible adverse
NSR 9 - Ealand Poultry Farm	Negligible adverse	Negligible adverse
NSR 10 - North Moor Farm	Negligible adverse	Negligible adverse
Potentially significant effects are in bold *At NSR 1 during the night-time, the significance of effect assigned is based upon the ambient sound levels without/with train passbys on the nearby railway line		

9.6.28 Should works on the River Water Abstraction Option be undertaken, effects could be major adverse (**significant**) during the daytime period in the vicinity of NSR 4. This effect would be short-term (estimated to be 25 days of piling) and is predicted due to the short distance between the closest of the properties in this NSR group to the river water abstraction point. Should the preferred Canal Water Abstraction Option be selected, the closest property in this receptor group would be approximately 600m from the works area and effects would be **not significant** at NSR 4 or at any other receptor.

Noise effects of Mabey Bridge construction

9.6.29 The effects of the predicted construction noise levels due to sheet piling activities during Mabey Bridge replacement are shown in Table 9.26.

Table 9.26: Indicative Mabey Bridge replacement effects

Receptor	Daytime	Evening	Night-time
NSR 7 - Keadby Grange	Negligible adverse	Negligible adverse	Minor adverse
NSR 8 - North Pilfrey Farm	Negligible adverse	Negligible adverse	Minor adverse
NSR 11 - South Pilfrey Farm	Negligible adverse	Minor adverse	**Major adverse**

Receptor	Daytime	Evening	Night-time
Potentially significant effects are in bold Only the key receptors of NSR 7, NSR 8 and NSR 11 are included in this table. Where an NSR is significantly further from the construction area than the closest NSR, significant noise effects are not likely if noise levels are suitably controlled at the closer key representative receptors.			

9.6.30 During the daytime core hours and Saturday mornings, predicted noise effects continuous flight auger piling for the replacement of Mabey Bridge are assessed as negligible adverse (**not significant**). Should it be necessary to undertake works in the night-time at the same intensity as daytime works, major adverse effects (**significant**) are predicted at one of the three NSR.

Summary of evening/ night-time construction noise effects

9.6.31 In view of the potential for significant adverse noise effects in the evening/ night-time (and weekend) periods, construction activities taking place outside core working hours will need to be planned, managed and controlled appropriately so they do not exceed the SOAEL threshold values, as provided in Table 9.18, and reduce levels towards the LOAEL (or less) where practical. Provided the SOAEL threshold values are not exceeded, construction activities outside core working hours can be considered as having a minor adverse effect or less (**not significant**). Potential measures to ensure that appropriate mitigation is in place during the works are as set out in Section 9.5.

Proposed PCC Site construction - vibration effects

9.6.32 The level of impact at different receptors will be dependent upon a number of factors, including distance between the works and receptors, ground conditions, the nature and method of works required close to receptors and the specific activities being undertaken at any given time.

9.6.33 However, due to large distances (minimum of 400m) between residential receptors and the static plant that is likely to produce higher levels of vibration (e.g. piling rigs) on the Main Site, vibration effects on both humans and buildings are likely to be negligible (**not significant**).

9.6.34 NSR 1A is the closest receptor to the mobile construction plant likely to be associated with the Proposed PCC Site construction, being circa 40m from a potential option for a laydown area (refer to **Figure 5.1** in ES Volume III - **Application Document Ref. 6.4**). However, these types of mobile plant are unlikely to produce levels of vibration which would significantly affect humans or buildings and would therefore be classified as minor adverse (**not significant**) or less.

9.6.35 The Stainforth and Keadby Canal lies approximately 300m to the south of the Main Site, whilst Keadby Lock (NSR 12) is over 1km from any vibration sources on the Main Site. Given these distances, vibration effects on canal

infrastructure due to Main Site construction works are likely to be negligible (**not significant**).

Water connections construction - vibration effects

9.6.36 The River Water Abstraction Option, if chosen, would involve construction of a cofferdam. To provide a reasonable worst-case assessment, it has been assumed that sheet piling may be required, which could provide a potential significant source of vibration. The nearest NSR would be located circa 22m from the closest piling (NSR 4 - a group of properties including Blacksmiths Cottage, formerly Trentvale Preparatory School) (refer to Table 9.4).

9.6.37 Assuming sheet piling would similarly be used in the event that the preferred Canal Water Abstraction Option is selected, predictions have also been made for the nearest receptors to this option.

9.6.38 There is the potential for some vibration impacts upon humans and buildings during sheet piling. It is considered unlikely that most typical construction working routines would generate levels of vibration above which building damage would be expected to be sustained (subject to final plant and working requirements). However, there is the potential that vibration impacts could cause annoyance to occupants and exceed the LOAEL and SOAEL set out in Section 9.3. Therefore, prediction of vibration from sheet piling for installation of the cofferdam at the NSR has been made based upon a worst-case assumption that hammer driven piling may be required. Predictions are shown in Table 9.27.

Table 9.27: Predicted vibration effects due to construction of a cofferdam for River or Canal Water Abstraction Options

Water Abstraction Option	**River Water Abstraction Option**		**Canal Water Abstraction Option**	
NSR	Blacksmiths Cottage (NSR 4)	Keadby Lock (NSR 12)	Vazon Bridge (NSR 1A)	Stainforth and Keadby Canal walls
Predicted PPV (mm/s)	0.7	0.3	0.4	1.5
Magnitude of impact (assigned from Table 9.9/ Table 9.11*)	Low	Very Low	Low	Very Low

Water Abstraction Option	**River Water Abstraction Option**		**Canal Water Abstraction Option**	
Initial classification of effect (assigned from Table 9.13)	Minor adverse	Negligible adverse	Minor adverse	Negligible adverse
*NSR 4 and NSR 1A are residential so impact assigned using Table 9.9 for impacts on humans; Keadby Lock and the Stainforth and Keadby Canal Walls are structures so assigned using Table 9.11 for risk of building damage				

9.6.39 Vibration effects resulting from sheet piling for cofferdam installation/ removal are classified as minor adverse (**not significant**) for both the River Water Abstraction Option and the Canal Water Abstraction Option at the worst-affected receptor. The levels of vibration predicted may be just perceptible in residential environments. As prediction of vibration levels from driven piling requires the energy of the hammer drop and this information is not currently available, a worst-case assumption of the maximum energy value in the BS5228 Table E.1 method has been made, these predictions are therefore likely to overestimate vibration levels at the NSR.

9.6.40 The PPV vibration level predicted is significantly below the level at which building damage would begin to occur (PPV of 12.5 mm/s) for both options at the residential NSR, Keadby Lock and Stainforth and Keadby Canal walls. There is therefore negligible risk of damage to these buildings/ structures.

9.6.41 As vibration effects are classified as minor adverse (**not significant**) at these closest and potentially worst-affected receptors, it follows that there will not be any significant vibration effects at other NSR which are further from the cofferdam, either for the River Water Abstraction Option or Canal Water Abstraction Option.

9.6.42 The PPV vibration level predicted is above the LOAEL therefore there will be specific consideration regarding the control and mitigation of vibration within the final CEMP. Potential measures to ensure that appropriate mitigation is in place during the works are discussed in Section 9.5.

Waterborne transport offloading area construction - vibration effects

9.6.43 Works proposed at the Waterborne Transport Offloading Area (Railway Wharf) adjacent to Keadby Lock are limited to the maintenance of the existing jetty, and temporary placement of mobile crane(s) including the temporary oversailing of crane arms. No piling or other significant vibration inducing activities are proposed as it is considered that the recent improvements to the jetty are adequate for the AIL movements for the Proposed Development. As no sources of vibration require consideration, impacts associated to NSR 12

(Keadby Lock Scheduled Monument and Grade II listed building) are considered to be negligible (**not significant**).

Construction Traffic Noise Effects

9.6.44 For the purposes of assessment, it is assumed that construction traffic access to the proposed construction area will be via the A18. Data have been provided from the Transport Assessment (see **Appendix 10A**: Transport Assessment (ES Volume II – **Application Document Ref. 6.3**)) for the traffic scenario 'without' and 'with' Proposed Development construction traffic in 2031 for the roads within the scope of the transport assessment, as follows:

- scenario 1 – 'without' Proposed Development construction: 2031 Base + Committed development; and
- scenario 2 – 'with' Proposed Development construction: 2031 Base + Committed development + Proposed Development construction traffic.

9.6.45 It has been assumed as a worst-case approach that traffic speeds will remain the same for both scenarios although it is recognised that temporary speed restrictions are likely to be sought and used (as have been in place for the Keadby 2 Power Station construction) during construction. This would result in reduced speeds from 60 mph to 40 mph in the vicinity of the Proposed Development access from the A18.

9.6.46 The potential changes in road traffic noise from these roads as a result of the Proposed Development have been considered by calculating the CRTN BNL at 10m from the road and comparing the change. Table 9.28 presents the results of the assessment.

Table 9.28: Changes in road traffic noise as a result of construction of the Proposed Development

Link	Scenario a 'Without' Proposed Development construction traffic			Scenario b 'With' Proposed Development construction traffic			Change in BNL, dB (Scenario a minus Scenario b)	Classification of effect
	AAWT	%HGV	Speed (km/h)	AAWT	%HGV	Speed (km/h)		
A18 (west of Proposed Development Site access)	9,543	9.9	55	10,445	9.9	55	+0.4	Negligible adverse
A161 (between A18 and M180 Jct 2)	6,715	14.5	48	7,449	14.5	48	+0.5	Negligible adverse
A18 Station Road (west of Keadby Bridge)	17,326	7.4	33	17,660	7.4	33	+0.1	Negligible adverse
B1392 (north of Keadby Power Station site entrance)	1,860	8.1	32	1,860	8.1	32	0.0	Negligible adverse
B1392 (south of Keadby Power Station site entrance)	3,099	11.0	21	3,099	11.0	21	0.0	Negligible adverse

9.6.47 Table 9.28 shows either no change or very low change in road traffic noise due to traffic flows along the construction traffic routes of the Proposed Development. This will result in negligible adverse effects (**not significant**) at local residential NSR. Based upon the above, no further specific mitigation measures are required beyond those listed in Section 9.5.

9.6.48 In addition to the road traffic related to the Proposed Development construction, Abnormal Indivisible Loads (AIL), which arrive at the Waterborne Transport Off-Loading Area, would be offloaded using temporary mobile cranes and enter the Proposed Development Site via the Additional AIL Route. This is consistent with use of this land and route for AIL delivery during Keadby 2 Power Station construction. Details regarding the number of AIL movements will not be known until the contractor is appointed, but it is considered that road traffic noise from this potential source (individual infrequent passbys), in addition to noise from works already on-going, will be minor or negligible adverse (**not significant**).

Construction noise and vibration effects on sensitive ecological receptors

9.6.49 **Chapter 11**: Biodiversity and Nature Conservation (ES Volume I - **Application Document Ref. 6.2**) provides an assessment of potential impacts on ecological receptors in the context of the species likely to be present and their sensitivity to such disturbance effects. The Proposed Development Site connects to the River Trent at a location where construction impacts could have a substantive but temporary effect on the ability of migratory fish species to access breeding habitats in the wider River Trent catchment as a whole, and to return to the Humber Estuary from these habitats. The most likely potential mechanisms for such an impact are through either direct barriers to lamprey movement from any cofferdam, or indirect barriers to movement from noise and vibration disturbance (e.g. during piling operations).

9.6.50 Agreement of appropriate sensitive timings and construction working hours for any cofferdam installation and removal , if required in the River Trent, would be effective at avoiding potential for migrating fish to be affected. Given this, and the provision of a Fish Management Plan to support the proposed works, significant adverse effects on fish are unlikely as a result of direct and indirect barriers to migratory movements.

9.6.51 The potential for injury or mortality of fish and the extent to which intense underwater sound might cause an adverse environmental impact in particular fish species due to noise and vibration from piling has been considered in **Chapter 11**: Biodiversity and Nature Conservation (ES Volume I - **Application Document Ref. 6.2**) and accompanying **Appendix 11H** – Underwater Sound Effects on Fish (ES Volume II – **Application Document Ref. 6.3**). It is considered that piling and other construction works of limited extent and duration would be unlikely to adversely affect migratory fish. However, there will be specific consideration regarding the control and mitigation of impacts on fish, within the Final CEMP.

Carbon dioxide and other venting during commissioning and operation

9.6.52 A CO_2 venting system will be designed to collect and safely disperse abnormal CO_2 releases generated in the Proposed Development and needing to be discharged for safety reasons, for example due to plant over-pressurisation situations or due to maintenance activities. This venting system will comprise:

- small individual vents for minor emissions from equipment e.g. during routine maintenance;
- larger vents sized to safely dispose of larger volume emissions in an emergency scenario. The sizing of these vents is subject to ongoing work and would be confirmed at detailed design stage; and
- venting of steam lines and traps.

9.6.53 No planned operational venting of CO_2 or steam lines is expected during normal operation of the process and it is considered that noise associated with minor CO_2 venting from the Proposed Development would be **not significant** and in any event would be controlled by the Environmental Permit.

Operational noise effects

9.6.54 The final design of the Proposed Development is yet to be determined. Therefore, noise modelling has been undertaken based upon the indicative locations of operational equipment taken from **Figure 4.1** (ES Volume III - **Application Document Ref. 6.4**) and **Application Document Ref. 4.7**, and supplemented by a number of different potential operational scenarios of plant configuration, in order to give a view of the range of sound levels that could be produced by various unmitigated and mitigated options for the purposes of determining a representative worst-case. Using the Rochdale Envelope principles, reasonable worst-case operational noise impacts and effects have been assessed and are presented.

9.6.55 Further details of the sound source sound power level (L_w) data, the settings used in the noise modelling software and the list of assumptions used are presented in **Appendix 9B**: Operational Noise Information (ES Volume II - **Application Document Ref. 6.3**).

9.6.56 In the absence of additional mitigation, the predicted free-field operational *specific sound levels* at the NSR around the Proposed Development Site are presented in Table 9.29.

9.6.57 The NSR presented represent the worst affected within the study area. The plant will be designed to operate flexibly during its lifetime. Given the anticipated load regimes for the generating station (baseload and dispatchable), the predicted noise levels could apply to both the 1-hour daytime or 15-minute night-time BS 4142 assessment periods.

Table 9.29: Predicted worst-case operational *specific sound levels*

Receptor	Predicted operational *specific sound level* $L_{Aeq,T}$ dB
NSR 1 - Vazon Bridge	47
NSR 1A - Roe Farm	48
NSR 2 - Hawthorne House, Chapel Lane	44
NSR 3 - Keadby Village	41
NSR 4 - Mariners Arms Flats	38
NSR 5 - Trent Side	36
NSR 6 - 9 Queens Crescent	36
NSR 7 - Keadby Grange	44
NSR 8 - North Pilfrey Farm	40
NSR 9 - Ealand Poultry Farm	36
NSR 10 - North Moor Farm	45

9.6.58 The representative *background sound levels* are presented in Table 9.30. Adjustments have been made to the *background sound levels* to predict future *background sound levels* accounting for the change in sound level anticipated when the consented Keadby 2 Power Station becomes operational. With the exception of NSR 1 during the daytime, it is assumed that the *background sound level* will increase by the same amount as the *ambient sound level*, as a result of the operation of Keadby 2 Power Station.

9.6.59 At NSR 1 during the daytime, the predicted Keadby 2 Power Station *specific sound level* has been summed with the Keadby 2 ES representative *background sound level* to determine the representative future *background sound level*. This is because the sound level from Keadby 2 Power Station once operational will be dominant compared with existing sources of *background sound*. The derived future *background sound level* also correlates with the $L_{Aeq,T}$ 50dB free-field limit at Vazon Bridge (NSR 1) as set out in Condition 28 of the final Section 36 consent (BEIS, 2019) for Keadby 2 Power Station.

Table 9.30: Future *background sound levels*

Receptor	Time period	Keadby 2 Power Station ES representative *background sound level* ($L_{A90,T}$), dB	Representative future *background sound level* ($L_{A90,T}$), dB
NSR 1 - Vazon Bridge	Daytime	37	50
	Night-time	36	47
NSR 1A - Roe Farm*	Daytime	37	50

Receptor	Time period	Keadby 2 Power Station ES representative *background sound level* ($L_{A90,T}$), dB	Representative future *background sound level* ($L_{A90,T}$), dB
	Night-time	36	47
NSR 2 - Hawthorne House, Chapel Lane	Daytime	37	38
	Night-time	33	39
NSR 3 - Keadby Village	Daytime	35	36
	Night-time	30	34
NSR 4 - Mariners Arms Flats	Daytime	35	35
	Night-time	30	32
NSR 5 - Trent Side	Daytime	35	36
	Night-time	30	33
NSR 6 - 9 Queens Crescent (South Bank data)	Daytime	35	36
	Night-time	30	33
NSR 7 - Keadby Grange**	Daytime	35	35
	Night-time	30	32
NSR 8 - North Pilfrey Farm**	Daytime	35	35
	Night-time	30	31
NSR 9 - Ealand Poultry Farm**	Daytime	35	35
	Night-time	30	30
NSR 10 - North Moor Farm**	Daytime	35	36
	Night-time	30	33
* NSR 1A uses data for NSR 1 **For NSR 7-10 Keadby 2 Power Station *specific sound levels* are not available in the Keadby 2 Power Station ES. Therefore, the predicted values presented are from the remodelling of Keadby 2 Power Station in-situ, as set out in paragraph 9.3.47.			

BS4142 assessment results

9.6.60 The daytime BS 4142 assessments are presented in Table 9.31 and the night-time BS 4142 assessments are presented in

9.6.61 Table 9.32. The magnitude of impact and effect classification has been included in the tables, to provide context for the BS 4142 assessment outcomes, with reference to the semantic scales in Table 9.12, Table 9.13 and Table 9.14.

9.6.62 The values presented are the differences between the representative *background sound level* at each NSR (Table 9.15) and the predicted *rating level* (the *specific sound level* $L_{Aeq,T}$ presented in Table 9.29 plus the character correction). Positive values in the table indicate an excess of the *rating level* over the *background sound level*.

9.6.63 The assessment has assumed that potential noise of a tonal, impulsive or intermittent nature will be designed out of the Proposed Development during the detailed design phase by the selection of appropriate plant, building cladding, louvres and silencers/ attenuators as necessary. This is consistent with the Keadby 2 Power Station ES. However, inclusion of a +3 dB correction for other distinctive character has been included at this stage as a conservative approach for NSR with the potential to identify the new sound source in their existing acoustic environment.

Table 9.31: Daytime BS4142 assessment without additional mitigation

Receptor	NSR 1 Vazon Bridge	NSR 1A - Roe Farm	NSR 2 Hawthorne House, Chapel Lane	NSR 3 Keadby Village	NSR 4 Mariners Arms Flats	NSR 5 Trent Side	NSR 6 Queens Crescent	NSR 7 Keadby Grange	NSR 8 North Pilfrey Farm	NSR 9 Ealand Poultry Farm	NSR 10 North Moor Farm
Specific sound level L_s ($L_{Aeq,Tr}$), dB	52*	52*	44	41	38	36	36	44	40	36	45
Acoustic feature correction, dB	0*	0*	+3	+3	+3	+3	+3	+3	+3	+3	+3
Rating level ($L_{Ar,Tr}$), dB	52*	52*	47	44	41	39	39	47	43	39	48
Representative future *background sound level* ($L_{A90,T}$), dB	50*	50*	38	36	35	36	36	35	35	35	36
Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB	+2*	+2*	+9	+8	+6	+3	+3	+12	+8	+4	+12

Receptor	NSR 1 Vazon Bridge	NSR 1A - Roe Farm	NSR 2 Hawthorne House, Chapel Lane	NSR 3 Keadby Village	NSR 4 Mariners Arms Flats	NSR 5 Trent Side	NSR 6 Queens Crescent	NSR 7 Keadby Grange	NSR 8 North Pilfrey Farm	NSR 9 Ealand Poultry Farm	NSR 10 North Moor Farm
BS 4142:2014 effect category	Low/ Adverse	Low/ Adverse	Significant Adverse	Adverse/ Significant Adverse	Adverse	Low/ Adverse	Low/ Adverse	Significant Adverse	Adverse/ Significant Adverse	Adverse	Significant Adverse
Magnitude of impact (assigned from Table 9.12)	Very Low/ Low	Very Low/Low	Medium	Low/ Medium	Low	Very Low/Low	Very Low/Low	Medium/ High	Low/ Medium	Low	Medium/ High
Initial classification of effect (assigned from Table 9.14)	Negligible/ Minor adverse	Negligible / Minor adverse	**Moderate adverse**	Minor/ **Moderate adverse**	Minor adverse	Negligible / minor adverse	Negligible / minor adverse	**Moderate / Major adverse**	Minor/ **Moderate adverse**	Minor adverse	**Moderate / Major adverse**
*See further information in context discussion Uncertainty: Given the use of sound level data from surveys undertaken for Keadby 2 Power Station ES, significantly different 'representative' *background* and *ambient sound level* values could be obtained using updated baseline data and using different statistical analysis methods. Additionally, *background/ ambient sound level* data measured at a small number of NSR are assumed to be representative of conditions at other NSR; this is discussed in Table 9.30.											

Table 9.32: Night-time BS4142 assessment without additional mitigation

Receptor	NSR 1 Vazon Bridge	NSR 1A - Roe Farm	NSR 2 Hawthorne House, Chapel Lane	NSR 3 Keadby Village	NSR 4 Mariners Arms Flats	NSR 5 Trent Side	NSR 6 Queens Crescent	NSR 7 Keadby Grange	NSR 8 North Pilfrey Farm	NSR 9 Ealand Poultry Farm	NSR 10 North Moor Farm
Specific sound level L_s ($L_{Aeq,Tr}$), dB	47	48	44	41	38	36	36	44	40	36	45
Acoustic feature correction, dB	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3
Rating level ($L_{Ar,Tr}$), dB	50	51	47	44	41	39	39	47	43	39	48
Representative future *background sound level* ($L_{A90,T}$), dB	47	47	39	34	32	33	33	32	31	30	33
Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB	+3	+4	+8	+10	+9	+6	+6	+15	+12	+9	+15

Receptor	NSR 1 Vazon Bridge	NSR 1A - Roe Farm	NSR 2 Hawthorne House, Chapel Lane	NSR 3 Keadby Village	NSR 4 Mariners Arms Flats	NSR 5 Trent Side	NSR 6 Queens Crescent	NSR 7 Keadby Grange	NSR 8 North Pilfrey Farm	NSR 9 Ealand Poultry Farm	NSR 10 North Moor Farm
BS 4142:2014 assessment outcome	Low/ Adverse	Adverse	Adverse/ Significant adverse	Significant Adverse	Significant Adverse	Adverse	Adverse	Significant adverse	Significant adverse	Significant adverse	Significant adverse
Magnitude of impact (assigned from Table 9.12)	Very Low/ Low	Low	Low/ Medium	Medium	Medium	Low	Low	High	Medium/ High	Medium	High
Initial classification of effect (assigned from Table 9.14)	Negligible /Minor adverse	Minor adverse	Minor/ **Moderate adverse**	**Moderate adverse**	**Moderate adverse**	Minor adverse	Minor adverse	**Major adverse**	**Moderate/ Major adverse**	**Moderate adverse**	**Major adverse**
Uncertainty: Given the use of sound level data from surveys undertaken for Keadby 2 Power Station ES, significantly different 'representative' *background* and *ambient sound level* values could be obtained using updated baseline data and using different statistical analysis methods. Additionally, *background/ ambient sound level* data measured at a small number of NSRs are assumed to be representative of conditions at other NSR, this is discussed in Table 9.30.											

9.6.64 In accordance with Table 9.14, the values presented in Table 9.32 and Table 9.33, for the worst-case scenario produce a range of impact magnitudes from very low to high impact at the 11 NSR. This would result in effects between negligible/ minor adverse (**not significant**) to major adverse (**significant**), subject to consideration of context.

Consideration of context

9.6.65 Keadby 1 Power Station has been a continuously operating industrial source in the study area since 1996 and *background sound levels* measured for the Keadby 2 Power Station ES (whilst Keadby 1 Power Station was operational) were 2-4 dB higher in the daytime and 2-8 dB higher at night. This is likely to mean that residents at all NSR are already accustomed to an industrial source. As Keadby 2 Power Station will be operational before the Proposed Development and will potentially operate at the same times as the Proposed Development, it is reasonable to assume that local residents may become further accustomed to an industrial sound source before the Proposed Development is operational.

9.6.66 At NSR 1 and NSR 1A during the day, no correction for other distinctive character has been applied to the *rating level*. This is because sound from Keadby 2 Power Station is predicted to be 3 dB higher at this NSR than the Proposed Development, and as these will potentially operate at the same time, sound from the Proposed Development is unlikely to be significantly identifiable. Also, a *specific sound level* and *rating level* of 52 dB $L_{Aeq,1h}$ has been used during the day, rather than the 47 dB $L_{Aeq,1h}$ as presented in Table 9.29. The higher *rating level* provides what is deemed a more representative outcome from the BS 4142 assessment, in the context of noise from the future operation of Keadby 2 Power Station at NSR 1. The +2 dB outcome represents the change in the excess of *rating level* over the future *background sound level* once Keadby 2 Power Station becomes operational (see further demonstration in Table 9.33 below).

9.6.67 At NSR 1, where negligible/ minor adverse effects are predicted during the day and night-time assessments, it is reasonable to assume that residents may already be accustomed to noise from the railway approximately 15m to the north and in particular, adjusted to effects of noise, particularly when using rooms of the property facing the Proposed Development. It is noted that as part of the Keadby 2 Power Station Project, enhancements were made to the property, including additional glazing, providing residents with further protection from the effects of noise when residing within the building.

9.6.68 Table 9.33 below presents existing and future predicted *ambient sound levels* (assuming constant operation through the night of both Keadby 2 Power Station and the Proposed Development) and compares them to the BS8233:2014 and WHO 'Guidelines for Community Noise' recommended indoor ambient sound level for sleeping. The recommended internal criterion is 30 dB $L_{Aeq,8h,}$ which

would be equivalent to an external criteria of 45 dB $L_{Aeq,8h}$ assuming open bedroom windows for ventilation.

Table 9.33: Comparison of night-time *ambient sound levels* without additional mitigation

Receptor	Proposed Development predicted operational *specific sound level* ($L_{Aeq,T}$ dB)	Keadby 2 Power Station ES - predicted Keadby 2 operational *specific sound level* ($L_{Aeq,T}$ dB)	Night-time *ambient sound level* measured before Keadby 2 and the Proposed Development ($L_{Aeq,8h}$ dB)	Night-time future *ambient sound level* predicted with Keadby 2 Power Station in operation ($L_{Aeq,8h}$ dB)	Night-time future *ambient sound level* predicted with the Proposed Development in operation ($L_{Aeq,8h}$ dB)	Change in Night-time future *ambient sound level* due to the Proposed Development (dB)
NSR 1 - Vazon Bridge	47	50	39	**50**	**52**	+2
NSR 1A - Roe Farm	48	50	39	**50**	**52**	+2
NSR 2 - Hawthorne House, Chapel Lane	44	39	36	41	**46**	+5
NSR 3 - Keadby Village (slightly different locations)	41	37	36	40	43	+3
NSR 4 - Mariners Arms Flats	38	31	36	37	41	+4

Receptor	**Proposed Development predicted operational *specific sound level* ($L_{Aeq,T}$ dB)**	**Keadby 2 Power Station ES - predicted Keadby 2 operational *specific sound level* ($L_{Aeq,T}$ dB)**	**Night-time *ambient sound level* measured before Keadby 2 and the Proposed Development ($L_{Aeq,8h}$ dB)**	**Night-time future *ambient sound level* predicted with Keadby 2 Power Station in operation ($L_{Aeq,8h}$ dB)**	**Night-time future *ambient sound level* predicted with the Proposed Development in operation ($L_{Aeq,8h}$ dB)**	**Change in Night-time future *ambient sound level* due to the Proposed Development (dB)**
NSR 5 - Trent Side	36	33	36	38	40	+2
NSR 6 - 9 Queens Crescent (slightly different locations)	36	33	36	38	40	+2
NSR 7 - Keadby Grange	44	33*	36**	38	45	+7
NSR 8 - North Pilfrey Farm	40	28*	36**	37	42	+5
NSR 9 - Ealand Poultry Farm	36	24*	36**	36	39	+3
NSR 10 - North Moor Farm	45	35*	36**	39	**46**	+7
Those above BS8233:2014 external criteria of 45 dB $L_{Aeq,8h}$ are in bold.						

Receptor	Proposed Development predicted operational *specific sound level* ($L_{Aeq,T}$ dB)	Keadby 2 Power Station ES - predicted Keadby 2 operational *specific sound level* ($L_{Aeq,T}$ dB)	Night-time *ambient sound level* measured before Keadby 2 and the Proposed Development ($L_{Aeq,8h}$ dB)	Night-time future *ambient sound level* predicted with Keadby 2 Power Station in operation ($L_{Aeq,8h}$ dB)	Night-time future *ambient sound level* predicted with the Proposed Development in operation ($L_{Aeq,8h}$ dB)	Change in Night-time future *ambient sound level* due to the Proposed Development (dB)
*For NSR 7-10 no prediction of Keadby 2 Power Station sound levels are available in the Keadby 2 Power Station ES, so predicted values from the re-creation of Keadby 2 Power Station in-situ have been used. **NSR 7-10 were not used for the Keadby 2 Power Station ES so the lowest ambient data measured have been used.						

9.6.69 As shown in Table 9.33 at NSR 3 to NSR 9, whilst ambient sound levels increase due to the predicted levels from the Proposed Development, they are all at or below the BS8233:2014/WHO external criterion, this would give ambient sound levels at or below the guideline internal values with windows open at night.

9.6.70 At NSR 1 and NRS 1A, predicted ambient levels with Keadby 2 Power Station in operation are above the guideline external value. Noise from the Proposed Development will result in a minor increase in ambient sound levels (+2 dB for both NSR). This is below the level of change in sound level that would be just perceptible under normal environmental conditions. At NSR 1 the *specific sound level* predicted for the Proposed Development is 3 dB lower than for Keadby 2 Power Station and is 2 dB lower for NSR 1A. The sound from the Proposed Development is therefore likely to be less disturbing than the sound from the consented Keadby 2 Power Station at NSR 1 and NSR 1A. For NSR 2 and NSR 10 sound from the Proposed Development will result in ambient sound levels above the BS8233:2014/WHO external criterion by 1 dB. This excess of the criterion would be below the level of change that is just perceptible under normal environmental conditions. With windows closed, internal noise levels would be below the recommended internal criterion at all NSR, with respect to noise from the existing ambient sound levels, Keadby 2 Power Station and the Proposed Development combined.

9.6.71 It is noted from consultation with NLC that they 'usually require that operational noise (*rating levels*) do not exceed the *background sound level* by more than +3 dB'. This requirement is not met by the initial (numerical) outcomes of the BS 4142 indicative predictions, although the further assessment above demonstrates that, with context, the effects are likely to be lower than the initial BS 4142 (numerical) outcomes might suggest.

9.6.72 Nevertheless, on the basis of the above and the potential desire to reduce noise levels to NLC's criteria (no greater than +3 dB excess of *rating level* over *background sound level*) or below, potential mitigation options to reduce sound levels have been considered and those required to achieve NLC's criteria are discussed in Section 9.7 (Mitigation, Monitoring and Enhancement Measures).

Decommissioning noise effects

9.6.73 The potential impacts and effects would require further consideration at the decommissioning stage of the Proposed Development, but potential measures to ensure that appropriate mitigation is in place during such works are detailed in Section 9.5.The effects of eventual decommissioning are considered to be comparable to, or less than, those assessed for construction activities and are therefore considered to be **not significant** for the Proposed PCC Site or electrical connections during day-time working. Up to major adverse (**significant**) effects may result from the temporary works required to decommission plant and equipment within the Water Connection Corridor during the daytime at NSR 4 – this effect primarily relates to the short distance

to the River Water Abstraction Option where works may be required. This means there is potential for short term significant effects of Water Connection Corridor decommissioning works, in the absence of mitigation.

9.6.74 Decommissioning would require submission of a DEMP to the relevant planning authority for its approval, secured by a Requirement of the draft DCO (**Application Document Ref. 2.1**). Appropriate best practice mitigation measures will be applied during any decommissioning works, as described in Section 9.5, and documented in a DEMP; no additional mitigation for decommissioning of the Proposed Development beyond such best practice specified in BS 5228 and Section 9.5 mitigation is considered necessary to specify at this stage.

9.7 Mitigation, Monitoring and Enhancement Measures

Construction

9.7.1 This assessment has identified no more than negligible/ minor adverse (**not significant**) noise effects at all but one residential NSR (NSR 4) group for construction works during daytime or Saturday morning working hours, and up to moderate/ major adverse (**significant**) noise effects if work were to take place at the same intensity during evenings/ night-time and/ or other weekend periods.

9.7.2 In the event that construction activities are required during evening/ night-time periods, levels in excess of the SOAEL for night-time works could occur at all but NSR 9, (depending on the nature of activities undertaken and intensity of working). This could result in a moderate/ major adverse (**significant**) noise effect at these NSR in the absence of additional mitigation. Measures would therefore be put in place to control or restrict activities during evenings/ night-time so as not to exceed the SOAEL or relevant noise limit at locations to be agreed with NLC. Control of construction noise and vibration is proposed to be secured by a Requirement of the draft DCO (**Application Document Ref. 2.1**). By timing construction works and avoiding noisier activities being undertaken at night, significant adverse effects can therefore be avoided.

9.7.3 The preferred approach for controlling construction noise and vibration is to reduce levels at source, where reasonably practicable. Sometimes a greater noise or vibration level may be acceptable if the overall construction time, and therefore length of disruption, is reduced.

9.7.4 The list of noise control measures presented within Section 9.5 of this chapter provides a detailed but not exhaustive list of construction noise management measures. The measures listed will be implemented and supplemented as necessary with further bespoke measures identified through further detailed assessment as part of the final CEMP. With respect to reduction of noise levels during cofferdam piling, this may include, but not be limited to, use of a temporary acoustic barrier alongside the River Trent, use of a partial enclosure around hammer, and the use of a non-metallic dolly between the hammer and

the driving helmet (for driven piling) to prevent metal on metal impact sound. The need for monitoring of noise and vibration levels during construction will also be determined through the detailed assessment undertaken.

9.7.5 Residual effects after mitigation are described in Section 11.9.

Operational noise

9.7.6 The operational assessment has assumed that potential sound of a tonal, impulsive or intermittent nature (according to BS4142: 2014) will be designed out of the Proposed Development during the detailed design phase through the selection of appropriate plant, building cladding, louvres and silencers/ attenuators as necessary. However, a +3 dB correction for distinctive character has been applied to the *specific sound levels* predicted from the Proposed Development, for NSR with the potential to identify the new sound source in their existing acoustic environment.

9.7.7 Based on the worst-case results presented in Table 9.31 and Table 9.32 mitigation would be required to achieve operational sound levels at the NLC criteria and below the SOAEL and LOAEL at the following NSR:

- NSR 2, NSR 3, NSR 4, NSR 7, NSR 8, NSR 9 and NSR 10 during the daytime; and
- NSR 1A, NSR 2, NSR 3, NSR 4, NSR 5, NSR 6, NSR 7, NSR 8, NSR 9 and NSR 10 during the night-time.

9.7.8 Table 9.34 outlines the overall range of attenuation required to achieve the daytime and night-time LOAEL criterion of *rating level* no greater than +5 dB above the defined representative *background sound level* at each NSR, and the lower NLC potential *rating level* requirement of no greater than +3dB above the defined representative *background sound level* at each NSR.

Table 9.34: Calculated sound attenuation requirements

NSR	Attenuation required to achieve LOAEL dB $L_{Aeq,T}$	Attenuation required to achieve NLC criterion dB $L_{Aeq,T}$	Attenuation required to achieve LOAEL dB $L_{Aeq,T}$	Attenuation required to achieve NLC criterion dB $L_{Aeq,T}$
	Daytime		Night-time	
NSR 1 - Vazon Bridge	-	-	-	-
NSR 1A - Roe Farm	-	-	-	1
NSR 2 - Hawthorne House, Chapel Lane	4	6	3	5
NSR 3 - Keadby Village (slightly different locations)	3	5	5	7
NSR 4 - Mariners Arms Flats	1	3	4	6
NSR 5 - Trent Side	-	-	1	3
NSR 6 - 9 Queens Crescent (slightly different locations)	-	-	1	3
NSR 7 - Keadby Grange	7	9	10	12
NSR 8 - North Pilfrey Farm	3	5	7	9
NSR 9 - Ealand Poultry Farm	-	1	4	6
NSR 10 - North Moor Farm	7	9	10	12
Receptors marked by a "-" already achieve the criteria				

9.7.9 In light of the required attenuation to achieve the defined noise criteria at the NSR, the attenuation required from the source sound power levels (listed in **Appendix 9B:** Operational Noise Information (ES Volume II – **Application**

Document Ref. 6.3) of the key noise emitting plant to meet the NLC criterion has been modelled. The attenuation required is listed in Table 9.35.

Table 9.35: Required attenuation of plant items/buildings

Plant item	**Attenuation Required to Achieve a *Rating Level* No Greater Than + 3 DB Above the Defined Representative *Background Sound Level* (In Both Daytime and Night-Time) DB $L_{AEQ,T}$**
CCP compressor	20
Absorber stack casing	18
Absorber stack exhaust (point of emission to atmosphere)	12
All pumps (Absorber auxiliaries, amine pumps, chemical storage pumps, compressor pumps, DCC auxiliaries, fire water tank pumps, steam condensate pumps)	12
HRSG walls and roof	10
Hybrid cooling towers	5
Turbine intake	3
Note: It may be desirable to apply lower attenuation to some of these plant items/buildings, if so greater attenuations would need to be applied to other plant items/buildings	

9.7.10 Mitigation measures and general principles to achieve this may include, but not be limited to, the following depending upon potential benefits achieved from such measures:

- reducing the breakout noise from plant through use of enhanced enclosures, or potentially containing them within a building;
- reducing air inlet noise emissions by addition of further in-line attenuation;
- reducing stack outlet noise emissions by addition of silencers or sound proofing panels;
- reducing fin fan cooler noise emissions by screening, re-sizing, fitting low noise fans or attenuation;
- screening or enclosing the compressors or other equipment;
- use of screening or bunding to shield receptors from noise sources; or

- orientation of plant within the Site to provide screening of low-level noise sources by other buildings and structures, or orientating fans and the air inlets away from sensitive receptors.

9.7.11 Consultation with project engineers has confirmed the levels of sound reduction identified in Table 9.35 are achievable either through reduction of sound power level at source of the plant procured or the measures listed in this Section. During detailed design of the plant it may be desirable or more practical to apply higher attenuation to some plant items/buildings than listed in Table 9.35 in order to reduce the attenuation applied to other plant items/buildings and still achieve the NLC criterion.

9.7.12 Residual effects after mitigation are described in Section 11.9 and are considered to be **not significant** if noise levels are reduced to the NLC criterion (no greater than +3 dB excess of *rating level* over the *background sound level*) which is below the LOAEL (no greater than +5 dB excess of *rating level* over the *background sound level*).

9.7.13 During detailed design, an operational noise control scheme (including agreed noise limits) will be prepared, secured by a Requirement of the draft DCO (**Application Document Ref 2.1**), which would demonstrate use of Best Available Techniques (BAT) for the control of noise for the Environmental Permit.

9.8 Limitations or Difficulties

Baseline sound surveys

9.8.1 The COVID-19 outbreak presented challenges in obtaining representative baseline sound levels because typical road, air and rail transport usage have been reduced by travel restrictions and social distancing measures. Other sound sources may also have been affected – for example, due to changes in operating patterns at industrial and commercial premises. Therefore, sound level data from the 2015 and 2016 sound surveys undertaken as part of the Keadby 2 Power Station ES have been used to inform the assessments in this chapter. The approach to monitoring has been agreed with NLC.

9.8.2 It is considered that these data are likely to still be representative of the current noise climate at the monitoring locations for which data are available, with any new surveys during detailed design unlikely to yield significantly different *background* and *ambient sound levels* to those reported in this chapter. However, additional baseline measurements during the detailed design stage would help confirm assumptions regarding the baseline used from the Keadby 2 Power Station ES for NSR not assessed in the Keadby 2 Power Station ES.

9.8.3 Additional surveys would be designed to both cover gaps in the baseline data and to verify the data collected in 2015/2016. The monitoring requirements, locations and duration of monitoring, including whether baseline sound levels

can be considered typical during the proposed monitoring dates, should be agreed in advance with NLC.

Construction

9.8.4 Detailed construction information is not yet available (given that the construction contractor has not yet been appointed) and therefore this assessment draws upon the experience and assessments undertaken for other similar projects.

9.8.5 The assessment is quantitative, but indicative, although it is considered to be reasonable. However, construction noise thresholds (limit values) are based upon existing ambient sound levels at NSR. Further assessment has been identified as being required pre-construction, to ensure that appropriate mitigation measures are developed to achieve the BS 5228 ABC threshold noise values once the contractor is appointed. This and other mitigation measures detailed in Section 9.5 and Section 9.7 will be included in the final CEMP to minimise construction noise and vibration effects.

Operation

9.8.6 Assumptions made during the noise modelling and assessment of the Proposed Development are as presented in **Appendix 9B**: Operational Noise Information (ES Volume II - **Application Document Ref. 6.3**). It is considered that the assumptions result in the assessment being conservative.

9.8.7 Sound emission data for key sound emitting plant/ buildings within the Proposed Development (including turbine halls, Heat Recovery Steam Generator (HRSG), peaking plant) have been taken from the Keadby 2 Power Station ES data. Detailed cladding specifications for the Keadby 2 Power Station buildings have not been available during this assessment therefore an alternative approach has been used. During modelling of the Keadby 2 Power Station in-situ as part of this assessment, adjustments have been made to the sound source data for different plant items located in buildings to represent the potential sound reduction provided by building cladding. Adjustments were performed iteratively until the predicted sound levels at nearby NSR calibrated closely with those reported in the Keadby 2 Power Station ES.

9.8.8 Sound level data for the CCP plant have been taken from the Karsto CCS FEED study or has been assumed to be a free-field sound pressure level of 85 dB $L_{Aeq,T}$ at 1m external to the CCP buildings/ plant shells for the compressor and absorber stack. The CCP absorber and DCC sound power levels have initially been calculated based on the free-field sound pressure level of 85 dB $L_{Aeq,T}$ at 1m, assuming no additional containment. Both sound sources have then been enclosed in a 100mm thick concrete structure, resulting in a reverberant internal sound environment within each structure. The internal reverberant sound pressure level has been calculated within each structure, and these levels have been used to calculate the sound breakout from each structure, in order to predict noise levels at NSR. Values used for the hybrid cooling were for an

already mitigated option with low noise fans, fan silencers and acoustic attenuators on air intakes leading to significantly lower sound power level.

9.8.9 The final design of the Proposed Development is yet to be determined. Therefore, the operational noise modelling undertaken has considered a representative worst-case using the Rochdale Envelope principles, assessing both unmitigated and mitigated scenarios. Given the requirement for additional mitigation measures, further assessment will be undertaken at the detailed design stage, to control noise emissions in order to meet the appropriate noise limits secured by a Requirement of the DCO (**Application Document Ref. 2.1**) at nearby NSR.

9.8.10 With respect to deriving representative *background sound levels* for use in the BS 4142 assessment, consideration should be given to wind direction in order to accord with the predicted operational sound levels derived from ISO 9613 method, which assumes gentle downwind conditions. The predicted levels presented in this assessment will only actually be experienced at each NSR when it is downwind of the Proposed PCC Site. Consequently, it is appropriate to compare these predicted levels with *background sound levels* measured in similar conditions.

9.8.11 There is no reliable method of predicting upwind propagation as there are too many variables. However, the upwind sound levels from an individual sound source will generally be 10-15 dB lower than the downwind sound levels. The difference between the upwind and downwind *background sound levels* at the receptors was smaller than this (at 1-5 dB) as they have contributions from sources located all around them. So, the potential impact of the Proposed Development would be at its greatest in downwind conditions.

9.9 Summary of likely significant residual effects

9.9.1 A summary of the likely significant residual effects, following the implementation of appropriate mitigation to reduce noise and vibration during construction, operation and decommissioning phases, is presented in Table 9.36 below.

Table 9.36: Summary of likely significant residual effects

Development stage	**Predicted Impact**	**Classification of effect prior to mitigation**	**Mitigation/ enhancement (if identified)**	**Residual effect**	**Nature of effect (Lt/ Mt/ St and P/ T and D/ In)**
Construction	Noise effects on residential NSR during construction of the Proposed PCC Site and Electrical Connection to 132kv Substation Option and Water Connection Corridor (daytime) – except NSR 4 (see below)	Negligible/ minor adverse (**not significant**)	Not required	Negligible/ minor adverse (**not significant**) on the basis that mitigation is employed such that the BS 5228 ABC noise limits are met, and the Section 9.5 mitigation guidance is followed	St, T, D
Construction	Noise and vibration effects on residential NSR 4 group receptor during construction on Water Connection Corridor (daytime) – **if River Water**	Up to moderate/ major adverse (**significant**)	Further detailed assessment and CEMP once contractor appointed	Up to minor adverse (**not significant**) at receptors represented by NSR 4 (including at Blacksmiths Cottage and 19 Trentside), on the	St, T, D

Development stage	Predicted Impact	Classification of effect prior to mitigation	Mitigation/ enhancement (if identified)	Residual effect	Nature of effect (Lt/ Mt/ St and P/ T and D/ In)
	Abstraction Option selected			basis that mitigation is employed such that the BS 5228 ABC noise limits are met, and the Section 9.5 mitigation guidance is followed	
Construction	Noise effects on residential NSR during construction of the Proposed PCC Site and Electrical Connection to 132kv Substation Option (evening/ night-time)	Negligible adverse (**not significant**) up to major adverse (**significant**)	Further detailed assessment and CEMP once contractor appointed	Minor adverse (**not significant**) on the basis that mitigation is employed such that the BS 5228 ABC noise limits are met, and the Section 9.5 mitigation guidance is followed	St, T, D
Construction	Noise effects on residential NSR during Mabey	Negligible adverse (**not significant**)	Not required	Negligible adverse (**not significant**)	St, T, D

Development stage	**Predicted Impact**	**Classification of effect prior to mitigation**	**Mitigation/ enhancement (if identified)**	**Residual effect**	**Nature of effect (Lt/ Mt/ St and P/ T and D/ In)**
	Bridge replacement (daytime)				
Construction	Noise effects on residential NSR during Mabey Bridge replacement (evening/ night-time)	Minor adverse (not significant) up to major adverse (**significant**)	Further detailed assessment and CEMP once contractor appointed	Minor adverse (**not significant**) on the basis that mitigation is employed such that the BS 5228 ABC noise limits are met, and the Section 9.5 mitigation guidance is followed	St, T, D
Construction	Noise effects due to construction traffic	Negligible adverse (not significant)	Not required	Negligible adverse (**not significant**)	St, T, D
Construction	Vibration effects on sensitive receptors from works on Main Site (humans and buildings)	Negligible adverse (not significant)	Not required	Negligible adverse (**not significant**)	St, T, D

Development stage	Predicted Impact	Classification of effect prior to mitigation	Mitigation/ enhancement (if identified)	Residual effect	Nature of effect (Lt/ Mt/ St and P/ T and D/ In)
Construction	Vibration effects on sensitive receptors from River and Canal Water Abstraction Options cofferdam installation (humans, buildings, and structures)	Minor adverse or less (not significant)	Further detailed assessment and CEMP once contractor appointed.	Minor adverse or less (**not significant**)	St, T, D
Construction	Noise and vibration effects on ecological receptors within River Trent	Negligible/ Minor adverse or less (not significant)	Agreement of appropriate sensitive timings for any cofferdam installation and removal taking into account potential for migrating river and sea lamprey and other fish. Provision of a Fish Management Plan to support the relevant permitting for these works.	Negligible/ Minor adverse or less (**not significant**)	St, T, D

Development stage	Predicted Impact	Classification of effect prior to mitigation	Mitigation/ enhancement (if identified)	Residual effect	Nature of effect (Lt/ Mt/ St and P/ T and D/ In)
Operation	Operational effects on residential NSR	Negligible/ minor adverse (not significant) to **Major adverse** (significant) at night.	Application of practical sound mitigation to reduce relevant noise at source for the CCP compressors, absorber stack, absorber stack exhaust, HRSG walls and roof, all pumps, Hybrid cooling towers and turbine intake as shown in Table 9.35. During detailed design, an operational noise control scheme (including agreed noise limits) will be prepared, secured by a Requirement of the draft DCO (**Application**	Negligible/ minor adverse (**not significant**)	Mt, P, D

Development stage	Predicted Impact	Classification of effect prior to mitigation	Mitigation/ enhancement (if identified)	Residual effect	Nature of effect (Lt/ Mt/ St and P/ T and D/ In)
			Document Ref 2.1), which would demonstrate use of Best Available Techniques (BAT) for the control of noise for the Environmental Permit.		
Decommissioning	Noise effects during daytime decommissioning of the Main Site/ Electrical connections and Water Connection Corridor (except NSR 4)	Negligible/ Minor adverse	Not required	Negligible/ minor adverse (**not significant**)	St, T, D
Decommissioning	Noise effects at (NSR 4) during decommissioning of the Water Connection Corridor (if River	Up to **Major adverse** (significant)	This effect is primarily related to the distance between this NSR and the works. No additional	Minor adverse (**not significant**) on the basis that mitigation is employed such that the BS 5228 ABC	St, T, D

Development stage	Predicted Impact	Classification of effect prior to mitigation	Mitigation/ enhancement (if identified)	Residual effect	Nature of effect (Lt/ Mt/ St and P/ T and D/ In)
	Water Abstraction Option selected)		mitigation for decommissioning of the Proposed Development is specified at this stage but would be considered in advance of decommissioning to use BPM measures available at that time.	noise limits are met, and the Section 9.5 mitigation guidance is followed	

Note: Lt = long term, Mt = medium term, St = short term, P = permanent, T = temporary, D = direct and In = indirect.

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