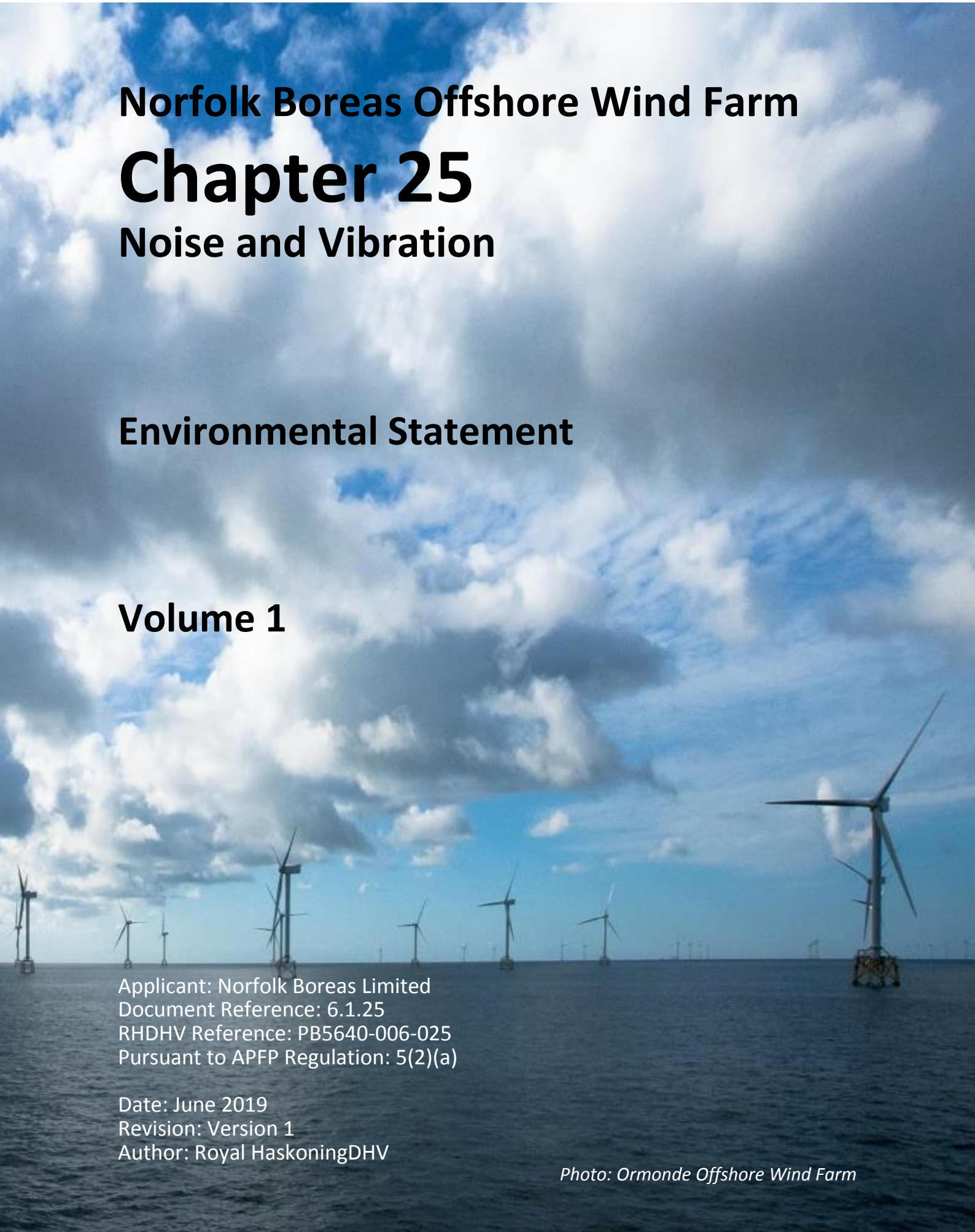
Norfolk Boreas Offshore Wind Farm

Chapter 25

Noise and Vibration

Environmental Statement

Volume 1



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Glossary of Acronyms

AAWT	Annual Average Weekday Traffic
BAT	Best Available Technology
BNL	Basic Noise Level
BPM	Best Practicable Means
BS	British Standard
CCW	Countryside Council for Wales
CIA	Cumulative Impact Assessment
CNMP	Construction Noise Management Plan
CoCP	Code of Construction Practice
CRTN	Calculation of Road Traffic Noise
CWS	County Wildlife Sites
DCO	Development Consent Order
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DMRB	Design Manual for Roads and Bridges
EPA	Environmental Protection Act
EPP	Evidence Plan Process
ES	Environmental Statement
ETG	Expert Topic Group
EU	European Union
eVDV	Estimated Vibration Dose Value
HDD	Horizontal Directional Drilling
HGV	Heavy Goods Vehicle
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IPC	Infrastructure Planning Commission
ISO	International Standards Organisation
LOAEL	Lowest Observed Adverse Effect Level
NOEL	No Observed Effect Level
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
NPS	National Policy Statement
NPSE	Noise Policy Statement for England
NSIP	Nationally Significant Infrastructure Project
NSR	Noise Sensitive Receptor
OAE	Observed Adverse Effect
OCoCP	Outline Code of Construction Practice
O&M	Operations and Maintenance
OTMP	Outline Traffic Management Plan
PEIR	Preliminary Environmental Information Report
PPG	Planning Practice Guidance
PPV	Peak Particle Velocity
PRoW	Public Rights of Way
SCADA	Supervisory Control and Data Acquisition

SLM	Sound Level Meter
SOAEL	Significant Observed Adverse Effect Level
SoS	Secretary of State
TMP	Traffic Management Plan
TRL	Transport Research Laboratory
TRRL	Transport and Road Research Laboratory
UAE	Unacceptable Adverse Effect
UAEL	Unacceptable Adverse Effect Level
VDV	Vibration Dose Value
VWPL	Vattenfall Wind Power Limited
WHO	World Health Organisation

Glossary of Terminology

C C_{tr}	The spectrum adaptation terms C and C_{tr} are used to take into account different source spectra as indicated in the standard. C: A-weighted Pink Noise spectrum. C_{tr}: A-weighted urban traffic noise spectrum. C and C_{tr} corrections can also be added to R_w (see below).
Cable logistics area	Existing hardstanding area to allow the storage of cable drums and associated materials and to accommodate a site office, welfare facilities and associated temporary infrastructure to support the cable pulling works.
Cable pulling	Installation of cables within pre-installed ducts from jointing pits located along the onshore cable route.
Converter Hall	A building containing plant and equipment which converts HVAC to HVDC or HVDC to HVAC.
dB(A)	Decibels measured on a sound level meter incorporating a frequency weighting (A weighting) which differentiates between sounds of different frequency (pitch) in a similar way to the human ear. Measurements in dB(A) broadly agree with people's assessment of loudness. A change of 3 dB(A) is the minimum perceptible under normal conditions, and a change of 10 dB(A) corresponds roughly to halving or doubling the loudness of a sound. The background noise level in a living room may be about 30 dB(A); normal conversation about 60 dB(A) at 1 metre; heavy road traffic about 80 dB(A) at 10 metres; the level near a pneumatic drill about 100 dB(A).
dB(Z) (or previously L_{leq})	Decibels measured on a sound level meter incorporating a flat frequency weighting (Z weighting) across the frequency range.
Decibel (dB)	A unit of noise level derived from the logarithm of the ratio between the value of a quantity and a reference value. It is used to describe the level of many different quantities. For sound pressure level the reference quantity is 20 µPa, the threshold of normal hearing is 0dB, and 140dB is the threshold of pain. A change of 1dB is only perceptible under controlled conditions. Under normal conditions a change in noise level of 3dB(A) is the smallest perceptible change.
Ducts	A duct is a length of underground piping, which is used to house electrical and communication cables.
Evidence Plan Process	A voluntary consultation process with specialist stakeholders to agree the approach to the EIA and information to support the HRA.
$L_{A10,T}$	The A weighted noise level exceeded for 10% of the specified measurement period (T). L_{A10} is the index generally adopted to assess traffic noise.
$L_{A90,T}$	The A weighted noise level exceeded for 90% of the specified measurement period (T). In BS 4142: 2014 it is used to define the 'background' noise level.
$L_{Aeq,T}$	The equivalent continuous sound level – the sound level of a notionally steady sound having the same energy as a fluctuating sound over a specified measurement period (T). $L_{Aeq,T}$ is used to describe many types of noise and can be measured directly with an integrating sound level meter.
L_{Amax}	The maximum A-weighted sound pressure level recorded during a measurement.
Landfall	Where the offshore cables come ashore at Happisburgh South.
Landfall compound	Compound at landfall within which HDD drilling would take place.
Mobilisation area	Areas approx. 100 x 100m used as access points to the running track for duct installation. Required to store equipment and provide welfare facilities.

	Located adjacent to the onshore cable route, accessible from local highways network suitable for the delivery of heavy and oversized materials and equipment.
National Grid new / replacement overhead line tower	New overhead line towers to be installed at the National Grid substation.
National Grid overhead line modifications	The works to be undertaken to complete the necessary modification to the existing 400kV overhead lines.
National Grid overhead line temporary works	Area within which the work will be undertaken to complete the necessary modification to the existing 400kV overhead lines.
National Grid substation extension	The permanent footprint of the National Grid substation extension.
National Grid temporary works area	Land adjacent to the Necton National Grid substation which would be temporarily required during construction of the National Grid substation extension.
Necton National Grid substation	The grid connection location for Norfolk Boreas and Norfolk Vanguard
Norfolk Vanguard	Norfolk Vanguard offshore wind farm, sister project of Norfolk Boreas.
Onshore 400kV cable route	Buried high-voltage cables linking the onshore project substation to the Necton National Grid substation.
Onshore cable route	The up to 35m working width within a 45m wide corridor which will contain the buried export cables as well as the temporary running track, topsoil storage and excavated material during construction.
Onshore cables	The cables which take power and communications from landfall to the onshore project substation.
Onshore infrastructure	The combined name for all onshore infrastructure associated with the project from landfall to grid connection.
Onshore project area	The area of the onshore infrastructure (landfall, onshore cable route, accesses, trenchless crossing zones and mobilisation areas; onshore project substation and extension to the Necton National Grid substation and overhead line modifications).
Onshore project substation	A compound containing electrical equipment to enable connection to the National Grid. The substation will convert the exported power from HVDC to HVAC, to 400kV (grid voltage). This also contains equipment to help maintain stable grid voltage.
Running track	The track along the onshore cable route which the construction traffic would use to access workfronts.
R_w	The weighted sound reduction index, R_w, is a single figure description of sound reduction index which is defined in BS EN ISO 717-1: 1997. The R_w is calculated from measurements in an acoustic laboratory to BS EN ISO 140-3:1997 and ratings to BS EN ISO 717-1:1997. Sound insulation ratings derived from site (which are invariably lower than the laboratory figures) are referred to as the R'w ratings (apparent weighted sound reduction index) and measured to BS EN ISO 140-4:1998
The Applicant	Norfolk Boreas Limited.
The project	Norfolk Boreas Wind Farm including the onshore and offshore infrastructure.

Transition pit	Underground structures that house the joints between the offshore export cables and the onshore cables.
Trenchless crossing compound	Pairs of compounds at each trenchless crossing zone to allow boring to take place from either side of the crossing.
Trenchless crossing zone	Areas within the onshore cable route which will house trenchless crossing entry and exit points.
Workfront	A length of onshore cable route within which duct installation works will occur, approximately 150m.

25 Onshore Noise and Vibration

25.1 Introduction

1. This chapter of the Environmental Statement (ES) considers the potential airborne noise and vibration impacts of the Norfolk Boreas Offshore Wind Farm (hereafter 'the project'). This chapter provides an overview of the baseline noise conditions for the onshore project area and identifies potentially sensitive receptors to noise and vibration. The chapter presents an assessment of the potential impacts and associated mitigation for the construction, operation and decommissioning of the project on these receptors.

2. The assessment also considers cumulative impacts of other proposed projects. The proposed methodology adhered to for the Environmental Impact Assessment (EIA) and Cumulative Impact Assessment (CIA) is discussed in section 25.4.

3. This chapter is supported by Appendix 25.1 Baseline Noise Survey, Appendix 25.2 Construction Phase Assessment, Appendix 25.3 Operational Phase Assessment and Appendix 24.4 Norfolk Vanguard Noise and Vibration Consultation Responses. Figures which accompany this chapter are provided in Volume 2 Figures.

4. Vattenfall Wind Power Limited (VWPL) (the parent company of Norfolk Boreas Limited) is also developing Norfolk Vanguard, a 'sister project' to Norfolk Boreas. In order to minimise impacts associated with onshore construction works for the two projects, Norfolk Vanguard are seeking to obtain consent to undertake enabling works for both projects at the same time. However, Norfolk Boreas needs to consider the possibility that Norfolk Vanguard may not proceed to construction.

5. The EIA has been undertaken using the following two alternative scenarios (further details are presented in Chapter 5 Project Description) and an assessment of potential impacts has been undertaken for each scenario:

   - **Scenario 1** – Norfolk Vanguard proceeds to construction and installs ducts and other shared enabling works for Norfolk Boreas.

   - **Scenario 2** – Norfolk Vanguard does not proceed to construction and Norfolk Boreas proceeds alone. Norfolk Boreas undertakes all works required as an independent project.

6. Potential impacts in relation to noise and vibration inter-relate with other technical topics as presented within other chapters of the ES. These are referenced within this chapter and consists of:

   - Chapter 22 Onshore Ecology;
   - Chapter 23 Onshore Ornithology;

- Chapter 24 Traffic and Transport;
- Chapter 27 Human Health;
- Chapter 28 Onshore Archaeology and Cultural Heritage; and
- Chapter 30 Tourism and Recreation.

25.2 Legislation, Guidance and Policy

25.2.1 Legislation

7. This section provides details on key pieces of international and UK legislation which are relevant to this chapter.

25.2.1.1 Environmental Protection Act 1990

8. Section 79 of the Environmental Protection Act 1990 (the EPA 1990) defines statutory nuisance with regard to noise and determines that local authorities have a duty to detect such nuisances in their area.

9. The EPA 1990 also defines the concept of 'Best Practicable Means' (BPM) as:

- *"'Practicable' means reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge and to the financial implications;*
- *The means to be employed include the design, installation, maintenance and manner and periods of operation of plant and machinery, and the design, construction and maintenance of buildings and structures;*
- *The test is to apply only so far as compatible with any duty imposed by law; and*
- *The test is to apply only so far as compatible with safety and safe working conditions, and with the exigencies of any emergency or unforeseeable circumstances."*

10. Section 80 of the EPA 1990 provides local authorities with powers to serve an abatement notice requiring the abatement of a nuisance or requiring works to be executed to prevent their occurrence.

25.2.1.2 The Control of Pollution Act 1974

11. Section 60 of the Control of Pollution Act 1974 provides powers to local authority officers to serve an abatement notice in respect of noise nuisance from construction works.

12. Section 61 provides a method by which a contractor can apply for 'prior consent' for construction activities before commencement of works. The 'prior consent' is agreed between the local authority and the contractor and may contain a range of agreed working conditions, noise limits and control measures designed to minimise or prevent the occurrence of noise nuisance from construction activities. Application

for a 'prior consent' is a commonly used control measure in respect of potential noise impacts from major construction works.

25.2.1.3 National Planning Policy

25.2.1.3.1 National Policy Statements (NPS)

13. The assessment of potential impacts upon onshore noise and vibration receptors has been made with specific reference to the relevant National Policy Statements (NPS). These are the principal decision-making documents for Nationally Significant Infrastructure Projects (NSIP). Those relevant to the project are:

- Overarching NPS for Energy (EN-1) (Department of Energy and Climate Change (DECC), 2011a);
- NPS for Renewable Energy Infrastructure (EN-3) (DECC, 2011b); and
- NPS for Electricity Networks Infrastructure (EN-5) (DECC, 2011c).

14. The specific assessment requirements for noise and vibration, as detailed in the NPSs, are summarised in Table 25.1, together with an indication of where each is addressed within the ES.

Table 25.1 Summary of NPS requirements

NPS Requirement	NPS Reference	ES Chapter Reference
Where noise impacts are likely to arise, the applicant should include: • 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; • 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 environment on any noise sensitive premises and noise sensitive areas; and • Measures to be employed in mitigating noise. • The nature and extent of the noise assessment should be proportionate to the likely noise impact.	EN-1, paragraph 5.11.4	Refer to section 25.4 for the assessment methodology for assessing potential noise and vibration impacts, section 25.5 for details on the existing noise environment including the identification of noise sensitive receptors and section 25.8 where any changes in noise levels as a result of the project are assessed, and any potential impacts and potential mitigation measures are identified.
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.	EN-1, paragraph 5.11.5	Refer to section 25.8 where any changes in noise levels as a result of the project from

NPS Requirement	NPS Reference	ES Chapter Reference
		ancillary works, for example vehicle movements, are assessed and any potential impacts and potential mitigation measures are identified.
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 renewables (EN-3) and electricity networks (EN-5) there are 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.	EN-1, paragraph 5.11.6	Noise assessment described within EN-3 and EN-5 relates to the offshore environment. Those potential noise impacts are considered separately within Chapter 11 Fish and Shellfish and Chapter 12 Marine Mammals. The current relevant British Standards (BS) have been used within this assessment detailed within section 25.2.2.
The applicant should consult EA and Natural England (NE), or the Countryside Council for Wales (CCW), 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 affected species in nearby sites may also need to be taken into account.	EN-1, paragraph 5.11.7	Noise impacts on terrestrial protected species or other wildlife is considered within Chapter 22 Onshore Ecology and Chapter 23 Onshore Ornithology.
While standard methods of assessment and interpretation using the principles of the relevant British Standards are satisfactory for dry weather conditions, they are not appropriate for assessing noise during rain. This is when overhead line noise mostly occurs, and when the background noise itself will vary according to the intensity of the rain. Therefore, an alternative noise assessment method to deal with rain-induced noise is needed, such as the one developed by National Grid as described in report TR (T) 94,199319. This follows recommendations broadly outlined in ISO 1996 (BS 7445:1991) and in that respect, is consistent with BS 4142:1997. The IPC [now the Planning Inspectorate and the Secretary of State] is likely to be able to regard it as acceptable for the applicant to use this or another methodology that appropriately addresses these particular issues.	EN-5, paragraphs 2.9.8 and 2.9.9	Construction of a new overhead line will not be required. Some adaptations to the existing National Grid overhead line are proposed to take place under Scenario 2; however, this does not involve altering the geographical position of the line and further operational assessment of rain-induced noise is not considered necessary. BS 4142:1997 was superseded in 2014.

NPS Requirement	NPS Reference	ES Chapter Reference
		Where BS 4142 is referred to in this document, the 2014 revision has been applied which is in accordance with current best practice. See Chapter 5 Project Description for more information on works related to overhead lines.

15. EN-1 states in paragraph 4.1.5 that:

- *"Other matters that the Infrastructure Planning Commission (IPC) may consider important and relevant to its decision-making may include Development Plan Documents or other documents in the Local Development Framework. In the event of a conflict between these or any other documents and an NPS, the NPS prevails for the purposes of IPC decision making given the national significance of the infrastructure".*

25.2.1.3.2 National Planning Policy Framework, 2019

16. The National Planning Policy Framework (NPPF) was introduced in March 2012 replacing the former Planning Policy Guidance 24: Planning and Noise. It was revised in July 2018 and in February 2019 and this document now forms the basis of the Government's planning policies for England and how these should be applied.

17. Paragraph 170 of the NPPF (Ministry of Housing, Communities and Local Government (MHCLG), 2018) states planning policies and decisions should contribute to and enhance the natural and local environment by:

18. *"……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……"*

19. Furthermore, Paragraph 180 of the NPPF states:

20. *"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:*

21. *a) 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;*

22. *b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason; and*

23. *c) limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation."*

24. The NPPF also refers to the Noise Policy Statement for England (NPSE) (Department for Environment, Food and Rural Affairs (Defra), 2010).

25.2.1.3.3 Noise Policy Statement for England, 2010

25. The NPSE document was published by Defra in 2010 and paragraph 1.7 states three policy aims:

- *"Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:*
  - *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 improvement of health and quality of life."*

26. The first two points require that significant adverse impacts should not occur and that, where a noise level falls between a level which represents the lowest observable adverse effect and a level which represents a significant observed adverse effect:

- *"…all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life whilst also taking into consideration the guiding principles of sustainable development. This does not mean that such effects cannot occur."* (Paragraph 2.24, NPSE, March 2010).

27. Section 2.20 of the NPSE introduces key phrases including 'significant adverse' and 'adverse' and two established concepts from toxicology that are being applied to noise impacts:

- *"NOEL – No Observed Effect Level; this is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise; and*
- *"LOAEL – Lowest Observed Adverse Effect Level; this is the level above which adverse effects on health and quality of life can be detected".*

28. Paragraph 2.21 of the NPSE extends the concepts described above and leads to a significant observed adverse effect level (SOAEL), which is defined as the level above which significant effects on health and quality of life occur.

29. The NPSE states:

- *"It is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations"* (Paragraph 2.22, NPSE, March 2010).

30. Furthermore, paragraph 2.22 of the NPSE acknowledges that:

- *"Further research is required to increase understanding of what may constitute a significant adverse effect on health and quality of life from noise".*

31. However not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available.

25.2.1.3.4 National Planning Practice Guidance for Noise (NPPG) 2014

32. The National Planning Practice Guidance for Noise (NPPG Noise) (MHCLG, 2014), issued under the NPPF, states that noise needs to be considered when new developments may create additional noise and when new developments would be sensitive to the prevailing acoustic environment. When preparing local or neighbourhood plans, or making decisions about new development, there may also be opportunities to consider improvements to the acoustic environment.

25.2.1.4 Local Planning Policy

33. The onshore project area also falls wholly within the jurisdiction of Norfolk County Council, and within the following local authority boundaries:

- Breckland Council;
- Broadland District Council; and
- North Norfolk District Council.

34. Table 25.2 provides details of these local authorities' local planning policy documents and the relevant policies in respect of onshore noise and vibration.

Table 25.2 Relevant local planning policies

Document	Policy/ guidance	Policy/ guidance purpose
Breckland Council		
Breckland Council Adopted Core Strategy and Development Control Policies Development Plan Document (2009)	CP9 Pollution and Waste	To ensure high quality management of the environment through careful appraisal of development proposals to ensure pollution emissions, including noise, are minimised.
	CP12 Energy	To ensure low carbon renewable energy development is supported within the district whilst ensuring comprehensive environmental assessment is undertaken

Document	Policy/ guidance	Policy/ guidance purpose
		for the consent of large scale developments. The policy justification highlights noise impact on the surrounding area as a key issue.
	DC1 Protection of Amenity	To ensure development does not negatively impact on the amenity of neighbouring occupants, or future occupants with regards to many issues including noise and vibration.
	Policy DC15 Renewable Energy	To support proposals for renewable development and prevent any detrimental impact on local amenity as a result of noise.
Broadland District Council		
Broadland District Council Site Allocations DPD (2016)	P. 156 – Section 14 Amenity	To protect residential amenity from the adverse effects of noise and vibration.
North Norfolk District Council		
North Norfolk District Council Core Strategy (2008)	Policy EN7 Renewable Energy	To support proposals for renewable development and prevent any detrimental impact on residential amenity as a result of a variety of environmental concerns including noise.
	Policy EN13 Pollution and Hazard Prevention and Minimisation	To prevent proposed developments contributing to any negative impact on the environment through ensuring future development proposals set out to minimise or reduce pollution including noise.
Norfolk County Council		
Norfolk County Council Core Strategy and Minerals and Waste Development Management Policies Development Plan (2011)	Core Strategy Policy CS14 Environmental Protection	To ensure development does not generate any unacceptable adverse impacts on the environment and to protect residential amenity from the adverse effects of noise and vibration.

25.2.2 Guidance

35. The guidance in the following sections has been applied to the noise and vibration assessment.

25.2.2.1 British Standard (BS) 4142:2014 – Method for Rating and Assessing Industrial and Commercial Sound

36. BS 4142 describes methods for rating and assessing sound of an industrial and/or commercial nature. The methods use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incidental.

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

37. Part 1 of this Standard provides recommendations for basic methods of noise and vibration control relating to construction and open sites where work activities/operations generate significant noise and/or vibration levels. The legislative background to noise and vibration control is described and recommendations are given regarding procedures for the establishment of effective liaison between developers, site operators and local authorities. This BS provides guidance on methods of predicting and measuring noise and assessing its impact on those exposed to it.

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

38. Part 2 of this Standard gives recommendations for basic methods of vibration control relating to construction and open sites where work activities/operations generate significant vibration levels. The Standard includes tables of vibration levels measured during piling operations throughout the UK. It provides guidance concerning methods of mitigating vibration from construction, particularly with regard to percussive piling.

25.2.2.4 BS 6472-1:2008 – Guide to Evaluation of Human Exposure to Vibration in Buildings

39. This standard provides general guidance on human exposure to building vibration in the range of 1Hz to 80Hz and includes curves of equal annoyance for humans. It also outlines the measurement methodology to be employed. It introduces the concept of Vibration Dose Value (VDV) and estimated Vibration Dose Value (eVDV) for the basis of assessment of the severity of impulsive and intermittent vibration levels, such as those caused by a series of trains passing a given location.

25.2.2.5 BS 7445: Parts 1 and 2 – Description and Measurement of Environmental Noise

40. This Standard provides details of the instrumentation and measurement techniques to be used when assessing environmental noise and defines the basic noise quantity as the continuous A-weighted sound pressure level (L_{Aeq}). Part 2 of BS 7445 replicates International Standards Organisation (ISO) 1996-2.

25.2.2.6 BS 8233:2014 – Guidance on Sound Insulation and Noise Reduction for Buildings

41. This Standard provides a methodology to calculate the noise levels entering a building through facades and facade elements and provides details of appropriate measures for sound insulation between dwellings. It includes recommended internal noise levels which are provided for a variety of situations and are based on World Health Organisation (WHO) recommendations.

25.2.2.7 Calculation of Road Traffic Noise (CRTN) 1988

42. The CRTN document (Department of Transport, 1988) provides a method for assessing noise from road traffic in the UK and a method of calculating noise levels from the Annual Average Weekday Traffic (AAWT) flows and from measured noise levels. Since publication in 1988 this document has been the nationally accepted standard in predicting noise levels from road traffic. The calculation methods provided include correction factors to take account of variables affecting the creation and propagation of road traffic noise, accounting for the percentage of heavy goods vehicles (HGV), different road surfacing, inclination, screening by barriers and relative height of source and receiver.

25.2.2.8 Design Manual for Roads and Bridges, 2011

43. Volume 11, Part 3, Section 7 provides guidance on the environmental assessment of noise impacts from road schemes. The Design Manual for Roads and Bridges (DMRB) (Highways Agency, 2011) contains advice and information on transport-related noise and vibration, which has relevance regarding the construction and operational traffic impacts affecting sensitive receptors adjacent to road networks. It also provides guideline significance criteria for assessing traffic related noise impacts.

25.2.2.9 ISO 3744

44. ISO 3744 specifies a method for measuring the sound pressure levels on a measurement surface enveloping a noise source, under essentially free field conditions near one or more reflecting planes, to calculate the sound power level produced by the noise source.

25.2.2.10 ISO 717

45. ISO 717 defines single-number quantities for airborne sound insulation in buildings and of building elements such as walls, floors, doors, and windows.

25.2.2.11 ISO 9613-2

46. ISO 9613 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 noise source.

25.2.2.12 WHO (2000) Guidelines for Community Noise

47. These guidelines present health-based noise limits intended to protect the population from exposure to excess noise. They present guideline limit values at which the likelihood of particular effects, such as sleep disturbance or annoyance, may increase. The guideline values are 50 or 55dB L_{Aeq} during the day, related to annoyance, and 45dB L_{Aeq} or 60dB L_{Amax} at night, related to sleep disturbance.

48. The Guidance states:

- *"The effects of noise in dwellings, typically, are sleep disturbance, annoyance and speech interference. For bedrooms the critical effect is sleep disturbance. Indoor guideline values for bedrooms are 30dB L_{Aeq} for continuous noise and 45dB L_{Amax} for single sound events. Lower noise levels may be disturbing depending on the nature of the source."*

49. The WHO guidance also highlights that:

- *"Night-time, outside sound levels about 1 metre from facades of living spaces should not exceed 45dB L_{Aeq}, so that people may sleep with bedroom windows open. This value was obtained by assuming that the noise reduction from outside to inside with the window open is 15dB. To enable casual conversation indoors during daytime, the sound level of interfering noise should not exceed 35dB L_{Aeq}. To protect the majority of people from being seriously annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 55dB L_{Aeq} on balconies, terraces and in outdoor living areas. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound level should not exceed 50dB L_{Aeq}. Where it is practical and feasible, the lower outdoor sound level should be considered the maximum desirable sound level for new development."*

25.2.2.13 WHO (2009) Night Noise Guidelines for Europe

50. In 2009, the WHO published the Night Noise Guidelines for Europe, which it describes as an extension to the WHO Guidelines for Community Noise (1999). It concludes that:

- *"Considering the scientific evidence on the thresholds of night noise exposure indicated by L_{night} outside as defined in the Environmental Noise Directive (2002148/EC), an L_{night} outside of 40dB should be the target of the night noise guideline (NNG) to protect the public, including the most vulnerable groups such as children, the chronically ill and the elderly. L_{night} outside value of 55dB is recommended as an interim target for those countries where the NNG cannot be achieved in the short term for various reasons, and where policy-makers choose to adopt a stepwise approach."*

51. WHO (2018) Environmental Noise Guidelines for the European Region

The guidance states:

- *"The main purpose of these guidelines is to provide recommendations for protecting human health from exposure to environmental noise originating from various sources: transportation (road traffic, railway and aircraft) noise, wind turbine noise and leisure noise. They provide robust public health advice*

underpinned by evidence, which is essential to drive policy action that will protect communities from the adverse effects of noise."

52. The Environmental Noise directive is transposed into UK Law by The Environmental Noise (England) Regulations 2006.

25.3 Consultation

53. Consultation is a key part of the EIA process and is an ongoing process throughout the lifecycle of the project, from the initial stages through to consent and post-consent. To date, consultation regarding noise and vibration has been conducted through the Scoping Report (Royal HaskoningDHV, 2017), the Evidence Plan Process (EPP), namely the Noise and Vibration Method Statement (Royal HaskoningDHV, 2018, unpublished) and the Preliminary Environmental Information Report (PEIR) (Norfolk Boreas Limited, 2018).

54. Full details of the project consultation process are presented within Chapter 7 Technical Consultation and the Consultation Report (document reference 5.1). A summary of the consultation undertaken for Norfolk Boreas is provided in Table 25.3.

55. As the majority of the onshore infrastructure for Norfolk Boreas and Norfolk Vanguard is co-located, the pre-application consultation undertaken for Norfolk Vanguard is relevant to both projects and has been used to inform the approach to this assessment. In addition, where possible any comment received as part of the Norfolk Vanguard examination process, up to Deadline 5 (20th March 2019) have also be considered. The Norfolk Vanguard responses considered are provided in Appendix 25.4.

Table 25.3 Norfolk Boreas Consulation Responses

Consultee	Document / Date	Comment	Response / where addressed in the ES chapter
Secretary of State (SoS)	Scoping Opinion June 2017	The SoS recommends that the baseline survey and assessment methodology and choice of noise receptors should be agreed with the relevant Environmental Health Officers and with the Environment Agency. The choice of receptors and assessment of effects during construction and operation should be based on a justified worst case scenario taking into particular account: • the relationship to Norfolk Vanguard (i.e. scenarios 1 and 2); • HVAC or HVDC options; and • works associated with the reconfiguration of the overhead	A baseline noise survey was undertaken at locations representative of the nearest sensitive receptors as agreed with the relevant local authorities during the Expert Topic Group (ETG) meetings for Norfolk Vanguard and through consultation on the Norfolk Boreas Method Statement. Refer to section 25.5.

Consultee	Document / Date	Comment	Response / where addressed in the ES chapter
		lines and upgrades to the existing Necton substation.	
SoS	Scoping Opinion June 2017	The Environmental Statement (ES) should provide a description of the noise generation aspects of the Proposed Development for both the construction and operation stage. Any distinctive tonal, impulsive or low frequency characteristics of the noise should be identified.	Refer to section 25.4.1
SoS	Scoping Opinion June 2017	Information should be provided on the types of vehicles and plant to be used during the construction phase. The assessment should consider a 'worst case' for receptors, i.e. that within the application site the vehicles and plant are located at the closest possible point to a receptor.	Refer to section 25.4.1.1.1 for assumptions and indicative plant list
SoS	Scoping Opinion June 2017	Information should be provided on the layout of onshore infrastructure (e.g. the cable relay station and the substation) and the main sources of noise from these elements should be identified. This should account for a 'worst case' scenario in terms of proximity to potential receptors as well as design layout and technology types as described above.	Refer to section 25.4.1.3 The selection of High Voltage Direct Current (HVDC) technology removes the requirement for a cable relay station.
SoS	Scoping Opinion June 2017	The SoS welcomes reference at paragraph 1246 to noise impacts being specifically addressed at sensitive receptors. This should consider any potential noise disturbance at night and other unsocial hours such as weekends and public holidays.	Refer to section 25.8
SoS	Scoping Opinion June 2017	Paragraph 1245 of the Scoping Report states that "vibration will only be considered as an issue where significant piling works are required"; however, no explanation has been given as to what 'significant piling works' are and the Scoping Report has not justified why vibration will not be considered for other construction and related activities e.g. HGV movements. The SoS is of the view that the ES should consider all potential sources of vibration, particularly those in proximity to residential and other sensitive receptors.	Refer to section 25.8.5.5 on vibration

Consultee	Document / Date	Comment	Response / where addressed in the ES chapter
SoS	Scoping Opinion June 2017	Paragraph 1263 of the Scoping Report states that "there are considered to be no other significant sources of vibration associated with the operational scheme", however this statement has not been justified. For example, no details on potential operational vibration from the cable relay station and the substation have been provided and at this stage their location and proximity to receptors has not yet been determined; therefore the SoS does not agree this can be scoped out at this stage. This is particularly pertinent due to the proximity of proposed infrastructure associated with the Proposed Development and the Norfolk Vanguard project.	Operational onshore project substation plant such as transformers and other wound power equipment vibrate at twice the power frequency i.e. 100Hz and associated harmonic frequencies e.g. 200Hz, 300Hz. However, the effects are **negligible** as industry standard require the use of vibration isolation pads to prevent transmission of ground borne vibration. "*Damping of noise radiating surfaces can reduce resonance and the reductions can be quite dramatic. However, the "damper" has to be carefully selected and designed for the specific situation"* (Environment Agency, 2004). The onshore project substation will be designed to achieve negligible levels of ground-borne vibration. Therefore, operational vibration can be scoped out of the EIA requirements for the operational phase of the project.
SoS	Scoping Opinion June 2017	Consideration should be given to the potential noise impacts resulting from the maintenance campaigns referred to in paragraph 248 of the Scoping Report, which are started to take place every summer and would require 24/7 working.	Noise levels associated with a maintenance campaign are not expected to greater than operational substation. Additionally, the requirement for a generator to be active during maintenance campaigns has been incorporated into the assessment of operational noise impacts in order to present a worst case. Details of this can be found in section 25.4.1.3.
SoS	Scoping Opinion June 2017	The SoS welcomes that the best practice measures will be set out in the CoCP.	An outline Code of Construction Practice (OCoCP) has been included as part of

Consultee	Document / Date	Comment	Response / where addressed in the ES chapter
			the Development Consent Order (DCO) application, which will set out the management measures for any onshore construction works associated with the project.
SoS	Scoping Opinion June 2017	The Scoping Report identifies potential operational mitigation measures, including the installation of acoustic enclosures and barriers and the construction of a landform/embankment around the substation. Where such measures are being relied upon as delivering specific acoustic attenuation (e.g. the 10dB reduction that is quoted in paragraph 1276), these assumptions should be clearly stated and justified as part of the assessment methodology. These measures should also be taken into account in other technical assessments, for example the landscape and visual assessment, ecological and flooding / drainage assessments.	Site specific mitigation measures have been proposed and assessed. The detailed design stage (post consent) will confirm and refine the proposed mitigation strategy.
SoS	Scoping Opinion June 2017	Paragraph 1285 of the Scoping Report states that the spatial coverage of the construction noise assessment would be "400m from the cable corridor routes where significant activities could affect noise sensitive receptors". The ES should clearly set out what 'significant activities' would comprise.	Noise sensitive receptors are shown on Figure 25.2. Section 25.8.3 details those aspects of the project that could potentially affect sensitive receptors.
SoS	Scoping Opinion June 2017	The SoS welcomes consideration of noise impacts on nature conservation areas. Consideration should also be given to ecological receptors (e.g. protected species) and appropriate cross reference made to the Onshore Ecology chapter of the ES.	Statutory designated sites are presented within Chapter 22 Onshore Ecology shows no sites are located within the noise and vibration study area, and one site (Pigney's Wood Local Nature Reserve) is located adjacent to the noise and vibration study area. Chapter 22 Onshore Ecology considers the impact of the proposed construction works at this site. The potential impacts at these sites have been identified as being of low magnitude and no

Consultee	Document / Date	Comment	Response / where addressed in the ES chapter
			significant impacts have been predicted. Additionally, Chapter 22 Onshore Ecology considers the impact of the proposed construction works at County Wildlife sites (CWS) in the vicinity of the project. The potential impacts at these sites have been identified as being of low magnitude and no significant impacts on onshore ecology have been predicted.
SoS	Scoping Opinion June 2017	Consideration should be given to monitoring noise complaints during construction and when the development is operational. Although this is referred to at Paragraph 1276 in terms of operation, there is no reference in terms of construction. The CoCP and any operational noise management strategies should identify such measures.	An OCoCP will be submitted alongside the DCO application, detailing the objectives for managing and minimising construction noise and vibration on-site and at nearby sensitive receptors. Detailed design of onshore assets will incorporate Best Available Technique (BAT) and BPM to minimise any associated noise impacts. Furthermore, in the unlikely event of an operational noise complaint, investigations will be undertaken with the relevant local authority.
Breckland Council	Scoping Opinion June 2017	Further consideration should be given to the potential impacts of low frequency noise and vibration associated with the operation of the substation and associated apparatus. This should also be considered as part of the potential cumulative impacts associated with the existing substation at Necton and any other proposals. It is stated this has been scoped out of the ES during the operational phase of the development.	As detailed the onshore project substation will be designed to achieve negligible levels of ground-borne vibration. Therefore, operational vibration has been scoped out of the EIA requirements for the operational phase of the project.
Necton Parish Council	Scoping Opinion June 2017	Construction noise calculations, provided in an easy to understand format, i.e. comparison with other similar noise types. This should also cover the length of time noise will be experienced and the mechanisms in place for monitoring, evaluation and a community	Refer to sections 25.8.5 and 25.8.6. An OCoCP will be submitted alongside the DCO application, detailing the objectives for managing and

Consultee	Document / Date	Comment	Response / where addressed in the ES chapter
		communication plan that includes advance warning as well as a detailed complaint management schedule with proper accountability and consequence	minimising construction noise and vibration on-site and at nearby sensitive receptors.
Norfolk County Council, Broadland District Council, North Norfolk District Council	January 2018 Norfolk Boreas Noise and Vibration Method Statement	No comments on the proposed methodology received.	No action required
Breckland Council	January 2018 Norfolk Boreas Noise and Vibration Method Statement	Agreement on proposed guidance and consultation and methodology.	No action required
North Norfolk District Council	PEIR / October 2018	Construction noise impacts and any complaint resolution will require comprehensive and well-resourced complaints procedures to resolve complaints and ensure the provision of suitable mitigation. In particular, the Swafield Road area has been highlighted as being affected by the construction phase and assurances are sought on mitigation measures here. Operational noise impacts have been highlighted (as part of Norfolk Vanguard) which may also apply to Norfolk Boreas. Details of the effectiveness of mitigation measures should be submitted to enable assessment and comment in terms of both their effectiveness and long-term maintenance.	The proposed working hours are committed to (save for essential, emergency or non-intrusive works): 0700 hours and 1900 hours Monday to Friday, and 0700 hours to 1300 hours Saturday, with no activity on Sundays or bank holidays. The construction working hours restrict the time that deliveries may be received at site, i.e. no deliveries would be received outside of the stated working hours. The control of deliveries is set out within the Outline Traffic Management Plan which requires contractors to use a booking system to limit deliveries to fixed timeslots. As part of the communication liaison process set out in the OCoCP (document reference 8.1) a complaints procedure will be established. Any complaints will be logged, investigated and, where appropriate, rectifying action

Consultee	Document / Date	Comment	Response / where addressed in the ES chapter
			will be taken. Should the complaints be related to construction noise then any investigation would likely include noise monitoring to determine any requirement for rectifying action. The operational noise mitigation will introduce standard mitigation measures to ensure that noise levels attributable to the operational substation do not exceed those limits set out in paragraph 109 and Table 25.42. This assessment demonstrates that standard commercially available noise mitigation is capable of achieving the noise reduction required.

25.4 Assessment Methodology

25.4.1 Impact Assessment Methodology

56. This section sets out the overall approach to the impact assessment, as agreed during ETG meetings for Norfolk Vanguard and through consultation on the Noise and Vibration Method Statement (Royal HaskoningDHV, 2018, unpublished).

57. The assessment considers the two-alternative scenarios as outlined in section 25.1.

58. It should be noted that the same methodology is used for both scenarios.

25.4.1.1 Construction Phase Noise Assessment

59. BS 5228:2009+A1:2014 describes several methods for assessing noise impacts during construction projects.

60. The approved approach, as outlined within the Noise and Vibration Method Statement (Royal HaskoningDHV, 2018, unpublished) and utilised in this ES is the threshold based 'ABC' method. The method is detailed within BS 5228, which specifies a construction noise limit based on the existing ambient noise level and for different periods of the day. The predicted construction noise levels were assessed against noise limits derived from advice within Annex E of BS 5228. Table 25.4, reproduced from BS 5228:2009+A1:2014 Table E.1, presents the criteria for selection of a noise limit for a specific receptor location.

Table 25.4 Construction noise threshold levels based on the ABC method (BS 5228)

Assessment category and threshold value period (L_{Aeq})	Threshold value, in decibels (dB)		
	Category A[A)]	Category B[B)]	Category C[C)]
Night time (23.00 – 07.00)	45	50	55
Evenings and weekends [D)]	55	60	65
Daytime (07.00 – 19.00) and Saturdays (07.00 – 13.00)	65	70	75
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 values.			
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 and 07.00–23.00 Sundays.			

61. The *'ABC method'* described in BS 5228 establishes that there is no impact below the three thresholds presented above.

62. BS 5228 states:

> *"If the site noise level exceeds the appropriate category value, then a potential significant effect is indicated. The assessor then needs to consider other project-specific factors, such as the number of receptors affected and the duration and character of the impact, to determine if there is a significant effect."*

63. The model used in this assessment incorporated noise sources located in the study area, nearby residential dwellings and other buildings, intervening ground cover and topographical information.

64. Noise levels for the construction phase were calculated using the methods and guidance in BS 5228. This Standard provides methods for predicting receptor noise levels from construction works based on the number and type of construction plant and activities operating on site, with corrections to account for:

- The 'on-time' of the plant, as a percentage of the assessment period;
- Distance from source to receptor;
- Acoustic screening by barriers, buildings or topography; and
- Ground type.

65. Construction noise impacts were assessed using the impact magnitude presented in Table 25.5 for the daytime period, Table 25.6 for the evening and weekend periods, and Table 25.7 for the night time.

Table 25.5 Day time construction noise significance criteria

Impact magnitude	Construction noise level (dB)		
	A 65dB threshold	B 70dB threshold	C 75dB threshold
No Impact	≤65	≤70	≤75
Negligible Adverse	≥65.1 - ≤65.9	≥70.1 - ≤70.9	≥75.1 - ≤75.9
Minor Adverse	≥66.0 - ≤67.9	≥71.0 - ≤72.9	≥76.0 - ≤77.9
Moderate Adverse	≥68.0 - ≤69.9	≥73.0 - ≤74.9	≥78.0 - ≤79.9
Major Adverse	≥70	≥75	≥80

Table 25.6 Evening and weekends construction noise significance criteria

Impact magnitude	Construction noise level (dB)		
	A 55dB threshold	B 60dB threshold	C 65dB threshold
No Impact	≤55	≤60	≤65
Negligible Adverse	≥55.1 - ≤55.9	≥60.1 - ≤60.9	≥65.1 - ≤65.9
Minor Adverse	≥56.0 - <57.9	≥61.0 - ≤62.9	≥66.0 - ≤67.9
Moderate Adverse	≥58.0 - <59.9	≥63.0 - ≤64.9	≥68.0 - ≤69.9
Major Adverse	≥60	≥65	≥70

Table 25.7 Night time construction noise significance criteria

Impact magnitude	Construction noise level (dB)		
	A 45dB threshold	B 50dB threshold	C 55dB threshold
No Impact	≤45	≤50	≤55
Negligible Adverse	≥45.1 - ≤45.9	≥50.1 - ≤50.9	≥55.1 - ≤55.9
Minor Adverse	≥46.0 - ≤47.9	≥51.0 - ≤52.9	≥56.0 - ≤57.9
Moderate Adverse	≥48.0 - ≤49.9	≥53.0 - ≤54.9	≥58.0 - ≤59.9
Major Adverse	≥50	≥55	≥60

66. A proposed construction phase programme for each scenario is provided in Chapter 5 Project Description and has been outlined in Table 25.8 and Table 25.9 below for reference.

67. Under Scenario 1 there is the potential that the landfall ducts could be installed at the same time as Norfolk Vanguard ducts to minimise the cumulative impacts of the project. Therefore, there are two programme options under Scenario 1 at the landfall which will need to be assessed for noise:

- Option A – landfall duct installation prior to cable pulling in 2024 and 2025; or

- Option B – landfall duct installation concurrently with Norfolk Vanguard in 2022 and 2023.

Table 25.8 Scenario 1 indicative project construction programme

Activity	Year							
	2022	2023	2024	2025	2026	2027	2028	2029
Landfall								
Duct Installation Option A								
Duct Installation Option B								
Cable pulling, Joint and Commission								
Phase 1								
Phase 2								
Onshore cable corridor								
Cable pulling, Joint and Commission								
Phase 1								
Phase 2								
Onshore project substation								
Preconstruction works								
Primary works								
Electrical plant installation and commission								
Phase 1								
Phase 2								

Table 25.9 Scenario 2 indicative project construction programme

Activity	Year							
	2021	2022	2023	2024	2025	2026	2027	2028
Landfall								
Duct Installation								
Cable Pulling, joint and commission								
Phase 1								
Phase 2								
Onshore cable corridor								
Preconstruction works								
Duct installation works								
Cable pulling, joint and commission								
Phase 1								
Phase 2								

Activity	Year							
	2021	2022	2023	2024	2025	2026	2027	2028
Onshore project substation								
Preconstruction works								
Primary works								
Electrical plant installation and commission								
Phase 1								
Phase 2								

25.4.1.1.1 Assumptions and indicative plant list

68. To present a conservative assessment for the purposes of this ES it has been assumed that the National Grid substation extension will be conducted during the same time as the construction of the onshore project substation and with the same plant requirements.

69. Under Scenario 2 modifications are required to the existing National Grid overhead line structures; however, as the line is not changing its geographical location, further assessment of the operational impacts of the proposed modifications in accordance with NPS EN-5, paragraphs 2.9.8 and 2.9.9 is not considered necessary and therefore is not considered further.

70. Based on Chapter 5 Project Description, an indicative list of construction equipment has been developed and are detailed in Table 25.10 to Table 25.15.

Table 25.10 Construction noise – onshore project substation and National Grid substation extension (Scenario 1 and 2)

Name	No.	Source Type	LwA dB(A)	On time Correction
Tracked Excavator	2	Point	107	75%
Backhoe Loader	2	Point	96	75%
Bulldozer	2	Point	108	75%
Dumper	2	Point	101	75%
Mobile Crane	2	Point	106	75%
Cement Mixer Truck (Discharging)	1	Point	103	50%
Truck Mounted Concrete Pump and Boom Arm	1	Point	108	50%
Piling	1*	Point	118	75%
*Modelled as 1 source with 75% on time as equivalent to 3 sources with 25% on time				

Table 25.11 Construction noise – duct installation (per workfront) (Scenario 2)

Name	No.	Source Type	LwA dB(A)	On time Correction
Bulldozer	1	Point	108	75%
Dump Truck	1	Point	107	75%
Tracked Excavator	1	Point	107	75%
Generator	1	Point	105	100%
Water Pump	1	Point	93	75%
Dump Truck	1	Line	115	15km/h
Lorry	1	Line	108	15km/h

Table 25.12 Construction noise – temporary access tracks and pre-construction works (Scenario 1 and 2)

Name	No.	Source Type	LwA dB(A)	On time Correction
Bulldozer	1	Point	108	75%
Tracked Excavator	1	Point	107	75%
Dump Truck	1	Point	107	75%
Asphalt spreader and road roller*	1	Point	108	75%
*Permanent access road to onshore project substation only				

Table 25.13 Construction noise – trenchless crossing (Scenario 2) and Landfall (Scenario 1 and 2)

Name	No.	Source Type	LwA dB(A)	On time Correction
Tracked Excavator	1	Point	107	50%
Backhoe Loader[1]	1	Point	96	50%
Bulldozer	1	Point	108	50%
Dumper[1]	1	Point	101	50%
Mobile Crane	1	Point	106	25%
Cement Mixer Truck (Discharging)	1	Point	103	25%
Truck Mounted Concrete Pump and Boom Arm	1	Point	108	25%
Piling*	1	Point	118	10%
Drilling Rig[1]	1	Point	105	75%
Water Pump[1]	1	Point	93	75%
Generator[1]	1	Point	105	100%

Name	No.	Source Type	LwA dB(A)	On time Correction
*Modelled as 1 source with 75% on time as equivalent to 3 sources with 25% on time [1]Plant to be utilised would be limited to that at a trenchless crossing and outside of normal working hours				

Table 25.14 Construction noise – mobilisation areas (Scenario 2)

Name	No.	Source Type	LwA dB(A)	On time Correction
Tracked Excavator*	1	Point	107	25%
Bulldozer*	1	Point	108	25%
Dumper*	1	Point	101	25%
Generator	1	Point	105	100%
*Pre-construction and demobilisation set up				

Table 25.15 Construction noise – cable pulling (per workfront) (Scenario 1 and 2)

Name	No.	Source Type	LwA dB(A)	On time Correction
Conveyor Drive Unit	1	Point	95	100%
Field Conveyor (Rollers)	2	Point	71	100%
Tracked Excavator	1	Point	107	50%
Cement Mixer Truck (Discharging)	1	Point	103	50%
Dump Truck	1	Point	107	50%
Water Pump	1	Point	93	75%
Generator	1	Point	105	100%

25.4.1.1.2 Road traffic noise and vibration emissions assessment

71. Following the methodology contained in DMRB (Volume 11, Section 3, Chapter 3) an initial screening assessment was undertaken to assess whether there would be any significant changes in traffic volume and composition on surrounding local roads as a result of the project. Any road links with a predicted increase in traffic volume of 25% or a decrease of 20% were identified. Such changes in traffic volume would correspond to a 1dB(A) change in noise level at the relevant road link. A change in noise level of less than 1dB(A) is regarded as being imperceptible, as this is less than the minimum perceptible 3dB(A) level and, therefore, of negligible magnitude. If there are no increases greater than 25% or a decrease of 25% or greater, then the DMRB guidance indicates that no further assessment needs to be conducted.

72. Links showing an increase of greater than 25% were assessed following the Basic Noise Level (BNL) calculation procedure within CRTN to predict a dB change for each link. The calculation also incorporates a correction for mean traffic speed and the percentage of heavy vehicles.

73. Construction phase road link dB change was assessed using the impact magnitude criteria in Table 25.16. The thresholds for differentiating the criteria are taken from DMRB for short-term impacts and are an indication of the relative change in ambient noise as a result of the project.

Table 25.16 Magnitude criteria for relative change due to road traffic (short term)

Change in noise level ($L_{A10\ (18\ hour)}$ dB)	Impact magnitude
0.0	No change
0.1 – 0.9	Negligible
1.0 – 2.9	Minor
3.0 – 4.9	Moderate
5.0+	Major

74. Paragraph 3.32 of DMRB states that:

> *"PPVs in the structure of buildings close to heavily trafficked roads rarely exceed 2 mm/s and typically are below 1 mm/s. Normal use of a building such as closing doors, walking on suspended wooden floors and operating domestic appliances can generate similar levels of vibration to those from road traffic"*

75. For the assessment year 2023, there are three road network links which have been identified through the assessment as resulting in moderate adverse impacts (Link 21, 25 and Link 69 see Appendix 25.2) with all others assessed as being minor adverse, negligible or no impact.

76. For the assessment year 2024, there are two road network links which have been identified through the assessment as resulting in moderate adverse impacts (Link 25 and Link 69 see Appendix 25.2) with all others assessed as being minor adverse, negligible or no impact.

77. These impacts would be temporary in nature. A Traffic Management Plan (TMP) (DCO Requirement 21) will be developed to ensure that the spatial and temporal impacts associated with the construction phase are minimised. An Outline Traffic Management Plan (OTMP) (document reference 8.8) has been prepared and submitted as part of the DCO application (see Chapter 24 Traffic and Transport).

78. Therefore, a detailed noise assessment associated with the construction phase road traffic is not required. The road traffic assessment methodology of assessing relative change opposed to detailed modelling was discussed and agreed as part of the ETG under the EPP as part of the Method Statement review by stakeholders.

25.4.1.2 Construction Phase Vibration Assessment

79. Ground-borne vibration can result from construction works and may lead to perceptible levels of vibration at nearby receptors, which at higher levels can cause annoyance to residents. In extreme cases, cosmetic or structural building damage can occur, however vibration levels have to be of a significant magnitude for this effect to be manifested and such cases are rare.

80. High vibration levels generally arise from 'heavy' construction works such as piling, deep excavation, or dynamic ground compaction. The use of piling during the construction of the onshore project substation may be required.

81. Annex E of BS 5228-2:2009+A1:2014 contains empirical formulae derived by Hiller and Crabb (2000) from field measurements relating to resultant peak particle velocity (PPV) with a number of other parameters for vibratory compaction, dynamic compaction, percussive and vibratory piling, the vibration of stone columns and tunnel boring operations. These prediction equations are based on the energy approach. Use of these empirical formulae enables resultant PPV to be predicted and for some activities (vibratory compaction, vibratory piling and vibrated stone columns) they can provide an indicator of the probability of these levels of PPV being exceeded.

82. The empirical equations for predicting construction-related vibration provide estimates in terms of PPV. Therefore, the consequences of predicted levels in terms of human perception and disturbance can be established through direct comparison with the BS 5228-2:2009+1A:2014 guidance vibration levels.

83. Ground-borne vibration assessments may be drawn from the empirical methods detailed in BS 5228-2:2009+1A:2014, in the Transport and Road Research Laboratory (TRRL) 246: Traffic: Traffic induced vibrations in buildings, and within the Transport Research Laboratory (TRL) Report 429 (2000): Ground-borne vibration caused by mechanical construction works.

84. However, these calculation methods rely on detailed information, including the type and number of plant being used, their location and the length of time they are in operation. Given the mobile nature of much of the plant that has the potential to impart sufficient energy into the ground, and the varying ground conditions in the immediate vicinity of the construction works, it was considered that an accurate representation of vibration conditions using these predictive methods was not possible.

85. Consequently, a series of calculations, following the methodologies referred to above, were carried out based on typical construction activities that have the potential to impart sufficient energy into the ground, applying reasonable worst case

assumptions in order to determine set-back distances at which critical vibration levels may occur.

86. Humans are very sensitive to vibration, which can result in concern being expressed at energy levels well below the threshold of damage. Guidance on the human response to vibration in buildings is found in BS 6472-1:2008 Guide to evaluation of human exposure to vibration in buildings, Part 1, Vibration sources other than blasting.

87. BS 6472 describes how to determine the VDV from frequency-weighted vibration measurements. VDV is defined by the following equation:

$$VDV_{b/d,\ day/night} = (\int_0^T a^4(t)dt)^{0.25}$$

88. The VDV is used to estimate the probability of adverse comment which might be expected from human beings experiencing vibration in buildings. Consideration is given to the time of day and use made of occupied space in buildings, whether residential, office or workshop.

89. BS 6472 states that in homes, adverse comment about building vibrations is likely when the vibration levels to which occupants are exposed are only slightly above thresholds of perception.

90. BS 6472 contains a methodology for assessing the human response to vibration in terms of either the VDV, or in terms of the acceleration or the peak velocity of the vibration, which is also referred to as PPV. The VDV is determined over a 16-hour daytime period or 8-hour night-time period.

91. The response of a building to ground-borne vibration is affected by the type of foundation, ground conditions, the building construction and the condition of the building. For construction vibration, the vibration level and effects detailed in Table 25.17 were adopted based on BS 5228. Limits for transient vibration, above which cosmetic damage could occur, are given numerically in terms of PPV.

Table 25.17 Transient vibration guide values for cosmetic damage

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4Hz to 15Hz	15Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50mms^{-1} at 4Hz and above	

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4Hz to 15Hz	15Hz and above
2	Un-reinforced or light framed structures Residential or light commercial type buildings	15mms^{-1} at 4Hz increasing to 20mms^{-1} at 15Hz	20mms^{-1} at 15Hz increasing to 50mms^{-1} at 40Hz and above

92. Table 25.18 lists the minimum set-back distances at which vibration levels of reportable significance for other typical construction activities may occur. BS 5228 calculation methods were used to derive the set-back distances outlined in Table 25.18.

Table 25.18 Predicted distances at which vibration levels may occur

Activity	Set-back distance at which vibration level (PPV) occurs			
	0.3 mm/s	1.0 mm/s	10 mm/s	15 mm/s
Vibratory Compaction (Start-up)	166m	65m	9m	6m
Vibratory Compaction (Steady State)	102m	44m	8m	6m
Percussive Piling	48m	19m	3m	2m
HGV Movement[1] on uneven Haul Route	277m	60m	3m	2m

93. Table 25.19 reproduced from research (Rockhill *et al.,* 2014) details minimum safe separation distance for piling activities from sensitive receptors to reduce the likelihood of cosmetic damage occurrence.

Table 25.19 Receptor proximity for indicated piling methods

Building type (limits on vibrations from Eurocode 3)	Piling Method		
	Press-in	25kJ drop hammer	170 kW 27Hz vibrohammer
Architectural merit	2.6m	29.6m	27.7m
Residential	0.5m	11.8m	13.8m
Light commercial	0.14m	5.9m	5.5m
Heavy industrial	0.06m	3.9m	3.7m
Buried services	0.03m	2.9m	2.2m

94. For construction vibration from sources other than blasting, the vibration level and effects presented in Table 25.20 were adopted based on Table B-1 of BS 5228-2.

[1] Vibration level based on a HGV moving at 5mph.

These levels and effects are based on human perception of vibration in residential environments.

Table 25.20 Construction vibration - impact magnitude

Vibration limit PPV (mm/s)	Interpreted significance to humans	Impact magnitude
≤0.14	Vibration unlikely to be perceptible	No Impact
0.14 to 0.3	Vibration might just be perceptible in the most sensitive situations for most vibration frequencies associated with construction	Negligible - Adverse
0.3 to 1.0	Vibration might just be perceptible in residential environments	Minor – Adverse
1.0 to ≤10.0	It is likely that vibration at this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents	Moderate – Adverse
≥10.0	Vibration is likely to be intolerable for any more than a brief exposure to this level	Major – Adverse

25.4.1.3 Operation Phase Assessment

95. Where there are noise sources such as fixed plant associated with onshore assets, the most appropriate assessment guidance is BS 4142:2014. The guidance describes a method of determining the level of noise of an industrial noise source and the existing background noise level.

96. BS 4142:2014 describes methods for rating and assessing sound of an industrial and/or commercial nature. The methods use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident, and combines procedures for assessing the impact in relation to:

- Sound from industrial and manufacturing processes;
- Sound from fixed installations which comprise mechanical and electrical plant and equipment;
- Sound from the loading and unloading of goods and materials at industrial and/or commercial premises; and
- Sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that from forklift trucks, or that from train or ship movements on or around an industrial and/or commercial site.

97. This standard is applicable to the determination of the following levels at outdoor locations:

- *"a) rating levels for sources of sound of an industrial and/or commercial nature; and*
- *b) ambient, background and residual sound levels, for the purposes of:*

  1) investigating complaints;
  2) assessing sound from proposed, new, modified or additional source(s) of sound of an industrial and/or commercial nature; and
  3) assessing sound at proposed new dwellings or premises used for residential purposes."

98. The standard incorporates a requirement for the assessment of uncertainty in environmental noise measurements and introduces the concepts of 'significant adverse impact' rather than likelihood of complaints. Common principles with the previous edition are the consideration of the characteristics of the sound under investigation, time of day and frequency of occurrence.

99. The standard applies to industrial/commercial and background noise levels outside residential buildings and for assessing whether existing and new industrial/commercial noise sources are likely to give rise to significant adverse impacts on the occupants living in the vicinity.

100. Assessment is undertaken by subtracting the measured background noise level from the rating level; the greater this difference, the greater the magnitude of the impact.

101. BS 4142 refers to the following:

- *"A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context;*
- *A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context; and*
- *The lower the rating level relative to the measured background sound level the less likely it is that the specific sound source 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".*

102. When assessing the noise from a source, which is classified as the Rated Noise Level, it is necessary to have regard to the acoustic features that may be present in the noise. Section 9.1 of BS 4142 states:

- *"Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, add a character correction to the specific sound level to obtain the rating level."*

103. An operational assessment in accordance with BS4142 has been undertaken for the onshore project substation as it is the only noise source associated with the operation phase. Due to the separation distance and existing ambient soundscape, and in agreement with Norfolk County Council, no penalty corrections for intermittency, tonality or impulsivity have been included. These acoustic features are added based on perceptibility at the receptor location. An indicative layout of the onshore project substation is detailed in Appendix 25.3, Plate 3.1.

104. The determination of the specific sound level free from sounds influencing the ambient sound at the assessment location is obtained by measurement or a combination of measurement and calculation. This is to be measured in terms of the $L_{Aeq, T}$, where 'T' is a reference period of:

- 1 hour during daytime hours (07:00 to 23:00 hours); and
- 15 minutes during night-time hours (23:00 to 07:00 hours).

105. The assessment of noise from proposed fixed plant associated with the project was considered at the nearest receptors.

106. To predict the noise from the operational aspects of the project, SoundPLAN noise modelling software was utilised. The model incorporated proposed buildings based on elevation drawings, proposed fixed plant and additional noise sources (such as temporary generating plant) associated with the project. The model also included nearby residential dwellings and other buildings in the onshore project area, intervening ground cover and topographical information.

107. Noise levels for the operational phase were predicted at the same Noise Sensitive Receptor (NSR) locations detailed in section 25.4.1.4. The calculation algorithm described in ISO 9613 was used in the operational noise propagation modelling exercise.

108. The magnitude of impacts based on a quantitative assessment of noise impact using BS 4142:2014 and applied to the operational assessment are summarised in Table 25.21.

Table 25.21 Operational noise impact magnitude criteria for industrial/ commercial noise sources

Rating level ($L_{Ar, Tr}$ dB)	Impact magnitude
≤ Measured L_{A90}	No change
= Measured L_{A90} dB to +3 dB	Negligible
Measured L_{A90} + 3 dB to 5 dB	Minor
Measured L_{A90} + 5 dB to 9.9 dB	Moderate
≥ Measured L_{A90} + 10 dB	Major

109. During consultation (at ETG meetings for Norfolk Vanguard Limited in 2017) with the Environmental Health Officer at Breckland Council, it was identified that there would be a requirement for noise emissions from the onshore project substation installation to comply with the following conditions to ensure that operational noise does not exceed the permitted noise levels of the existing Dudgeon Offshore Wind Farm substation:

- The noise rating level (defined as set out in BS 4142) from the operation of the substation shall not exceed 35 dB $L_{Aeq,\ (5\ minutes)}$ at any time at a free field location immediately adjacent to any noise sensitive location; and
- Noise from the operation of the substation shall not exceed a limit value of 32 dB $L_{Leq\ (15\ minutes)}$ in the 100 Hz third octave band, at any time at a free field location immediately adjacent to any noise sensitive location.

110. These limits as agreed would apply to Norfolk Boreas and any cumulative onshore electrical infrastructure.

25.4.1.3.1 Onshore project substation

111. In February 2018, a refined design was announced by Norfolk Boreas Limited which committed the project to utilising HVDC technology as the export system.

112. This assessment therefore represents the results of noise modelling based on the HVDC project design and updated performance specification received from the supply chain technology providers. This chapter sets out the modelling approach applied using HVDC along with the assumptions which underpin it.

113. It is important to note that the existing Necton National Grid substation will be extended to accommodate the onshore project substation connection under both scenarios and forms part of the Norfolk Boreas DCO application. The equipment required to extend the existing Necton National Grid substation does not include components which would contribute any significant noise contributions in the area. Operational noise levels are expected to be minimal as there are no transformers on the site and circuit breakers would be activated only during maintenance (typically every 5 years) or during a system fault (this was discussed as part of ETG meetings for Norfolk Vanguard; see Appendix 25.4, Norfolk Vanguard Noise and Vibration Consultation). The extension to the existing Necton National Grid substation is therefore not included as part of the noise modelling presented within this chapter and this has been agreed with Breckland Council.

114. The main HVDC noise sources associated with the onshore project substation have been identified within Table 25.22.

Table 25.22 HVDC noise sources (per onshore project substation)

Name	No.	Source Type	LwA dB(A)	Relative Height	Frequency (Hz) [dB(A)]								
					31.5	63	125	250	500	1000	2000	4000	8000
Harmonic Filter Reactors	6	Point	85.6	5.0m	22	47	83	48	80	78	21	17	17
Harmonic Filter Capacitors	12	Point	80.6	9.5m	21	44	78	45	75	73	20	16	16
Auto-transformers	8*	Box	97.8	9.5m	68	75	59	86	88	88	82	81	96
Cooling fans	4	Area	85.7	4.5m	66	66	68	78	80	80	78	74	64
Air Handling Unit	4	Point	75.7	3.0m	56	56	58	68	70	70	68	64	54
Converter Hall	2	Box	80.0	19.0m	-	-	80	-	56	-	-	-	-
*6no. active at any one given time													

115. All sound power levels were calculated using source measurements obtained by Norfolk Boreas Limited as provided by the suppliers of suitable substation equipment. The sound source data used represents noise emissions from onshore project substation components without additional sound mitigation measures applied. All sources were modelled using 100% output at all times to present a conservative assessment.

116. The attenuation afforded by the converter hall building is detailed in Table 25.23.

Table 25.23 Converter hall building noise attenuation

Name	Lw" dB(A)*	Rw	C	Ctr	Frequency (Hz) [dB(A)]					
					125	250	500	1000	2000	4000
Converter Hall building	45	48	-2	-6	32	35	45	55	60	51
Lw" signifies the calculated sound power level at each façade taking into consideration the attenuation detailed below and a Cd correction of -3dB to account for the internal dimensions and reflective surfaces.										

117. Operational maintenance activities will require the use of an additional generator which has been included with a 50% output to account for its limited usage required only during maintenance activities, detailed in Table 25.24.

Table 25.24 Operational maintenance (generator required)

Name	No.	Source Type	LwA dB(A)	On time Correction	Relative Height	Frequency (Hz) [dB(A)]							
						63	125	250	500	1000	2000	4000	8000
Generator	1	Point	85	50%	1.5m	84	78	61	58	57	52	49	41

118. This chapter also considers cumulative noise impacts from the operational Dudgeon Offshore Wind Farm onshore substation (hereafter referred to as 'Dudgeon substation') and Norfolk Vanguard onshore project substation with the project. Background noise values for this assessment and the cumulative assessment were derived from noise monitoring (detailed in Appendix 25.1) conducted whilst the Dudgeon substation was not operating at full capacity and as such the measured background noise levels are expected to be lower than when Dudgeon substation is at full capacity. The resulting L_{A90} values used in the assessment therefore provide a conservative baseline (i.e. lower noise levels to achieve) to inform the design of the Norfolk Boreas and Norfolk Vanguard onshore project substations and ensure the amenity of nearby residents.

25.4.1.4 Sensitivity

119. The aims of the NPPF and the NPSE require that a SOAEL should be 'avoided' and that where a noise level which falls between SOAEL and LOAEL, then according to the explanatory notes in the statement:

- *"…reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life whilst also taking into consideration the guiding principles of sustainable development. This does not mean that such effects cannot occur."*

120. Further guidance can be found in the Planning Practice Guidance (PPG) notes which summarise the noise exposure hierarchy based on the likely average response, as summarised in Table 25.25.

Table 25.25 Definitions of sensitivity levels for PPG noise exposure hierarchy (reproduced from the NPPF)

Perception	Examples of outcomes	Increasing 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	

Perception	Examples of outcomes	Increasing effect level	Action
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
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

121. Sensitive receptors, in the context of noise and vibration, are typically residential premises but can also include schools, places of worship and noise sensitive commercial premises. Table 25.26 presents the definitions used relating to the sensitivity of the receptor.

Table 25.26 Definitions of the different sensitivity levels for noise and vibration

Sensitivity	Definition	Examples
High	Receptor has very limited tolerance of effect	Noise Receptors have been categorised as high sensitivity where noise may be detrimental to vulnerable receptors. Such receptors include certain hospital wards (e.g. operating theatres or high dependency units) or care homes at night. Vibration Receptors have been categorised as high sensitivity where the receptors are listed buildings or Scheduled Monuments.
Medium	Receptor has limited tolerance of effect	Noise Receptors have been categorised as medium sensitivity where noise may cause disturbance and a level of protection is required but a level of tolerance is expected. Such subgroups include residential accommodation, private gardens, hospital wards, care homes, schools, universities, research facilities, national parks, (during the day); and temporary holiday accommodation at all times. Vibration Receptors have been categorised as medium sensitivity where the structural integrity of the structure is limited but the receptor is not a listed building or Scheduled Monument.
Low	Receptor has some tolerance of effect	Noise Receptors have been categorised as low sensitivity where noise may cause short duration effects in a recreational setting although particularly high noise levels may cause a moderate effect. Such subgroups include offices, shops, outdoor amenity areas, long distance footpaths, doctor's surgeries, sports facilities and places of worship. Vibration Receptors have been categorised as low sensitivity where the structural integrity of the structure is expected to be high. The level of vibration required to cause damage is very high and such levels are not expected to be reached during the project.
Negligible	Receptor generally tolerant of effect.	Noise Receptors have been categorised as negligible sensitivity where noise is not expected to be detrimental. Such subgroups include warehouses, light industry, car parks, and agricultural land. Vibration Receptors have been categorised as negligible sensitivity where vibration is not expected to be detrimental.

122. The closest human receptors to the project were determined during consultation with relevant stakeholders. Indicative NSRs are detailed in Table 25.27.

123. For each identified receptor or group of receptors a representative location was chosen for the assessment as detailed on Figure 25.2 and in Table 25.27.

124. Adaptations to the project design and onshore cable route have been made which means some baseline receptor locations became redundant. To present an appropriate and proportionate account of potential impacts; subsequent receptor locations have been added in the vicinity of the original location representative of a dwelling or group of dwellings at the closest point to the project. These have been denoted with an asterisk.

Table 25.27 Receptor identification, sensitivity and classification

Receptor Identifier	Receptor Classification	Receptor Sensitivity	British National Grid Coordinates	
			X	Y
Landfall				
LFR1H	Residential	Medium	638487	330860
LFR2H	Residential	Medium	638426	330620
LFR3H	Residential	Medium	638512	329817
LFR4H	Residential	Medium	639335	330243
Onshore cable route				
CRR1E	Residential	Medium	635955	331279
CRR1F	Residential	Medium	636234	330640
CRR1G	Residential	Medium	635922	330536
CRR2E	Residential	Medium	636342	330967
CRR2E*	Residential	Medium	636266	330857
CRR2F	Residential	Medium	636740	329994
CRR2G	Residential	Medium	636305	330188
CRR3E	Residential	Medium	635639	330637
CRR3F	Residential	Medium	637398	330249
CRR3G	Residential	Medium	635268	330521
CRR4E	Residential	Medium	634743	330872
CRR4G	Residential	Medium	635375	329810
CRR1	Residential	Medium	629201	331557
CRR2	Residential	Medium	628619	331677

Receptor Identifier	Receptor Classification	Receptor Sensitivity	British National Grid Coordinates	
			X	Y
CRR3	Residential	Medium	626857	331798
CRR4	Residential	Medium	624041	330725
CRR5	Residential	Medium	622796	330308
CRR6	Residential	Medium	621552	330315
CRR7	Residential	Medium	621539	329522
CRR8	Residential	Medium	621064	328819
CRR9	Residential	Medium	620112	328685
CRR10	Residential	Medium	617476	327674
CRR11	Residential	Medium	616340	326792
CRR12	Residential	Medium	614674	325519
CRR13	Residential	Medium	613566	324845
CRR14	Residential	Medium	612407	324571
CRR15	Residential	Medium	610614	323766
CRR16	Residential	Medium	610371	324051
CRR17	Residential	Medium	607760	323241
CRR17*	Residential	Medium	607783	323218
CRR18	Residential	Medium	607005	322752
CRR18*	Residential	Medium	607963	322050
CRR19	Residential	Medium	607222	321422
CRR20	Residential	Medium	606512	319754
CRR21	Residential	Medium	604278	318181
CRR22	Residential	Medium	604083	317158
CRR23	Residential	Medium	601848	315627
CRR24	Residential	Medium	602296	316062
CRR25	Residential	Medium	601162	315520
CRR26	Residential	Medium	599421	315165
CRR27	Residential	Medium	598860	314764
CRR27*	Residential	Medium	598449	315202

Receptor Identifier	Receptor Classification	Receptor Sensitivity	British National Grid Coordinates	
			X	Y
CRR28	Residential	Medium	596693	315074
CRR29	Residential	Medium	595124	313971
CRR30	Residential	Medium	594860	312829
CRR31	Residential	Medium	594432	312604
CRR32	Residential	Medium	594844	312217
CRR33	Residential	Medium	593103	311683
Onshore project substation and National Grid substation extension				
SSR1	Residential	Medium	588486	309896
SSR2	Residential	Medium	589787	309564
SSR3	Residential	Medium	592046	310041
SSR3*	Residential	Medium	592071	310047
SSR4	Residential	Medium	590955	311011
SSR4*	Residential	Medium	590959	310999
SSR5	Residential	Medium	588826	311107
SSR6	Residential	Medium	591717	311554
SSR6*	Residential	Medium	591718	311547
SSR7	Residential	Medium	589770	311296
SSR8	Residential	Medium	589914	311696
SSR9	Residential	Medium	591060	311805
SSR10	Residential	Medium	590741	309382
SSR11	Residential	Medium	588478	310811

25.4.1.5 Magnitude

125. Impact magnitude has been defined with consideration to the PPG guidance, spatial extent, duration, frequency and severity of the effect. Impact magnitude is defined in Table 25.28.

Table 25.28 Definitions of magnitude levels for noise and vibration receptors

Magnitude	Definition
High/major	Fundamental, permanent / irreversible changes, over the whole receptor, and / or fundamental alteration to key characteristics or features of the particular receptors character or distinctiveness.
Medium/moderate	Considerable, permanent / irreversible changes, over the majority of the receptor, and / or discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.
Low/minor	Discernible, temporary (throughout project duration) change, over a minority of the receptor, and / or limited but discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.
Negligible	Discernible, temporary (for part of the project duration) change, or barely discernible change for any length of time, over a small area of the receptor, and/or slight alteration to key characteristics or features of the particular receptors character or distinctiveness.
No Impact	No discernible, temporary change, or change for any length of time, over a small area of the receptor, and/no alteration to key characteristics or features of the particular receptors character or distinctiveness.

25.4.1.6 Impact Significance

126. Following the identification of receptor sensitivity and magnitude of the effect, it is possible to determine the significance of the impact. A matrix is presented in Table 25.29 and will be used wherever relevant.

Table 25.29 Impact significance matrix

		Negative magnitude				
		High/ Major	Medium/ Moderate	Low/ Minor	Negligible	No Impact
Sensitivity	High	*Major*	*Major*	*Moderate*	*Minor*	*Minor*
	Medium	*Major*	*Moderate*	*Minor*	*Minor*	*Negligible*
	Low	*Moderate*	*Minor*	*Minor*	*Negligible*	*Negligible*
	Negligible	*Minor*	*Negligible*	*Negligible*	*Negligible*	*Negligible*

127. For example, in terms of PPG guidance, an Unacceptable Adverse Effect Level (UAEL) is considered to align with a major/high impact in Table 25.30 for a medium sensitivity receptor.

128. Assessment of impact significance is qualitative and reliant on professional experience, interpretation and judgement. The matrix should therefore be viewed as a framework to aid understanding of how a judgement has been reached, rather than as a prescriptive, formulaic tool.

Table 25.30 Impact significance definitions

Impact Significance	Definition
Major	Very large or large change in receptor condition, both adverse or beneficial, which are likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or, could result in exceedance of statutory objectives and / or breaches of legislation. PPG - Unacceptable Adverse Effect (UAE)
Moderate	Intermediate change in receptor condition, which are likely to be important considerations at a local level. PPG - Significant Observed Adverse Effect (SOAEL)
Minor	Small change in receptor condition, which may be raised as local issues but are unlikely to be important in the decision-making process. PPG – Observed Adverse Effect (OAE)
Negligible	No discernible change in receptor condition. PPG – Lowest Observed Adverse Effect (LOAEL)
No impact	No change, therefore no impact to receptor condition. PPG – No Observed Effect (NOEL)

129. Note that for the purposes of this ES chapter, major and moderate impacts are considered to be significant. In addition, whilst minor impacts are not significant in their own right, it is important to distinguish these from other non-significant impacts as they may contribute to significant impacts cumulatively or through interactions.

130. Embedded mitigation is presented in section 25.8.1 and will be referred to and included in the initial assessment of impact. If the impact does not require mitigation (or none is possible) the residual impact will remain the same. If, however, mitigation is required there will be an assessment of the post-mitigation residual impact.

25.4.2 Cumulative Impact Assessment

131. For a general introduction to the methodology used for the CIA, please refer to Chapter 6 EIA Methodology. This chapter will focus on those cumulative impacts that are specific to noise and vibration.

132. For further details of the methods used for the CIA for noise and vibration, see section 25.9.

25.4.3 Transboundary Impact Assessment

133. There are no transboundary impacts with regards to noise and vibration as the onshore project area including access would not be sited in proximity to any international boundaries. Transboundary impacts are therefore scoped out of this assessment and will not be considered further.

25.5 Baseline Noise Survey

134. In order to characterise the existing noise climate within the Norfolk Boreas study area (section 25.6.1), a baseline noise survey was undertaken at locations representative of the nearest sensitive receptors (see Figure 25.1.1 in Appendix 25.1) as agreed with the relevant local authorities during the ETG meetings for Norfolk Vanguard and through consultation on the Norfolk Boreas Method Statement (detailed in Table 25.27). Measurements were conducted between 27th April and 24th May 2017.

135. Please refer to Appendix 25.1 for further details on the baseline noise survey methodology.

25.5.1 Survey Practice

136. Baseline survey measurements were conducted in accordance with current guidance, including BS 4142:2014 *Method for Rating and Assessing Industrial and Commercial Sound* and BS 7445:2003 *Description and measurement of environmental noise* and the methodology used was agreed with relevant stakeholders during ETG meetings.

137. Sound level meters (SLM) were fully calibrated, traceable to UKAS standards and satisfied the requirements of BS EN 61672-1:20131F for a 'Class 1' SLM.

138. For all measurement locations during the noise survey, SLMs were set to record the following:

- L_{Aeq} – the equivalent continuous sound pressure level over the measurement period. This parameter was standardised as pertinent for land use within BS 7445;
- L_{Amax} – the maximum sound pressure level occurring within the defined measurement period;
- L_{A90} – the sound pressure level exceeded for 90% of the measurement period and is indicative of the background noise level; and
- L_{A10} - the sound pressure level exceeded for 10% of the measurement period. The L_{A10} index is used within the CRTN as an appropriate descriptor of traffic noise.

139. The equivalent continuous sound pressure level (L_{Aeq}) is the conventional descriptor of environmental noise and is defined below:

$$L_{eq,T} = 10 \times \log\left[\frac{1}{T}\int \frac{\rho^2(t)\partial t}{\rho_0^2}\right] dB$$

140. Noise measurements are normally taken with an A-weighting (denoted by a subscript 'A') to approximate the frequency response of the human ear.

141. Noise measurements were conducted with the SLMs mounted on tripods at a height of between 1.2m and 1.5m above ground level and 3.5m away from any reflecting surface other than the ground, i.e. in free-field conditions. The instruments were calibrated before and after the survey using a portable calibrator. No significant deviation in the calibration level was observed.

142. A record of the meteorological conditions during the survey was made. Any measurements taken during periods of rain or when average wind speeds exceed 5ms^{-1} were screened from the results.

25.5.2 Deriving Background Levels

143. Background noise levels used in the assessment were obtained from the baseline measurements. The measurement locations used were considered to be representative of the nearest NSR and have been agreed with stakeholders during the ETG meetings for Norfolk Vanguard and through consultation on the Norfolk Boreas Method Statement.

144. The background noise levels for the unattended measurement periods (ranging from 5 to 7 days) were assessed using statistical analysis of the measured L_{A90} values.

145. Assessment values for receptor locations at the onshore project substation have been derived from long term and short-term measurements. Details of the baseline noise survey are presented in Appendix 25.1. At some locations, there was no long-term monitor set up, due to land access issues. At these locations, short-term attended monitoring was conducted. These locations are identified and discussed further in Appendix 25.1.

25.6 Scope

25.6.1 Study Area

146. The onshore infrastructure considered within this assessment includes the following elements:

- Landfall;

- Onshore cable route including accesses and jointing pits under both scenarios and trenchless crossing (e.g. Horizontal Directional Drilling (HDD)) zones, and mobilisation areas under Scenario 2 only;
- Onshore project substation;
- Extension to the Necton National Grid substation; and
- Overhead line modification at Necton National Grid substation (Scenario 2 only).

147. As agreed with stakeholders during the ETG meetings for Norfolk Vanguard and through consultation on the Norfolk Boreas Method Statement (Royal HaskoningDHV, 2018, unpublished) and as discussed in section 25.4.1.1, the National Grid substation extension and overhead line modifications are not considered within the operational noise assessment. Normal operational noise levels are expected to be minimal as there are no transformers on the site, and circuit breakers would be activated only during maintenance or during a system fault. As there are no significant operational noise sources within the National Grid substation extension during normal operation, the National Grid substation extension and overhead line modifications are not considered further within this assessment.

148. The study area for this noise and vibration assessment comprises the entire onshore project area, as described in Chapter 5 Project Description and as shown in Figure 25.1. Noise receptor locations identified within the study area can be found in Figure 25.2.

149. The study area for the landfall, onshore cable route, onshore project substation, National Grid substation extension and identified traffic routes are located within the administrative region of North Norfolk District Council, Broadland District Council, Breckland Council and Norwich City Council.

150. The extent of the study area for the construction phase road traffic noise and vibration assessment (sections 25.8.5.2 and 25.8.5.4) was based on details provided in Chapter 24 Traffic and Transport and as a result of traffic-specific ETG meetings and consultation. Please refer to Chapter 24 Traffic and Transport (section 24.5.1 and Figure 24.2 and Figure 24.3) for further information on how the study area has been defined.

151. This noise and vibration assessment draws on the information provided within Chapter 5 Project Description in order to define worst case assumptions which are outlined in section 25.8.3. These assumptions have been used in the noise and vibration impact assessments in sections 25.8 and 25.9.

25.6.2 Data Sources

152. In order to inform this assessment, consideration of the project infrastructure and surrounding environment within the onshore project area utilised existing available

geographical information including aerial and satellite photography and mapping data. This data was used in order to determine the nearest NSR's and noise sources present within the study area for use in the assessment.

153. Measurements of the existing ambient noise level were required to be taken at locations considered representative of nearby NSRs that had the potential to be affected by the construction and operation of the project.

154. Further details of the baseline noise survey are discussed in section 25.5 and full details can be found in Appendix 25.1.

155. The data sources used and their associated confidence levels which informed the desk-based assessment are provided in Table 25.31.

Table 25.31 Data sources

Data	Year	Coverage	Confidence
Google Maps Aerial Photography	2016	Noise and Vibration study area	High
APEM Aerial Photography	2017	Noise and Vibration study area	High
OS Mastermap	2017	Noise and Vibration study area	High
OS 5050	2017	Noise and Vibration study area	High
Construction Data (Project Design Statement)	2019	Landfall: • Duct installation; and • Cable pulling, jointing and commissioning. Onshore cable route: • Preconstruction works; • Duct installation works; and • Cable pulling, jointing and commissioning. Onshore project substation: • Preconstruction works; • Primary works; and • Electrical plant installation and commission. National Grid substation extension.	High
Operational Data (Project Design Statement)	2019	Onshore project substation	High

25.7 Existing Environment

156. The onshore project area, which runs from the landfall at Happisburgh South to the onshore project substation and the Necton National Grid substation, is predominantly rural in nature. The largest settlements within the area are at North Walsham, Aylsham, Reepham and Dereham, the Robertson Barracks at Swanton Morley and smaller villages and individual residential properties are located throughout the study area. The main noise sources within the study area are:

- The A47 and the A1067 roads in the west of the area;
- The A140 and the A149 roads in the east of the area;
- The Norwich to Holt railway line in the east of the area:
- The railway line at Dereham;
- Industrial areas at North Walsham, Aylsham and Dereham;
- Agricultural activities with associated machinery and plant; and
- The Robertson Barracks and Swanton Morley Airfield.

157. The onshore project substation is located near Necton to the west of the town of Dereham. The A47 is a heavily trafficked major trunk road through Norfolk (see Chapter 24 Traffic and Transport for more details) and therefore contributes substantially to existing background noise levels in the area, particularly at the properties closest to it. The area is generally rural in nature with Necton containing the largest concentration of residential properties. Smaller villages and individual residential properties are also located within the study area. Identified NSRs are detailed in Table 25.26.

25.7.1 Anticipated Trends in Baseline Conditions

158. The baseline noise survey detailed in section 25.5 and Appendix 25.1 outlines the existing soundscape within the study area of the project. Noise is managed and driven by European Union (EU), UK and local legislation and policies. The UK's noise strategy and standards are enacted through management actions at a local authority level as detailed in Table 25.2, section 25.2.1.4. There is a policy trend towards the achievement and maintenance of the noise environment across the UK, which is reflected in the local planning policies detailed in section 25.2.1.4. Predicted noise levels due to a change in land use, new developments and associated vehicles are assessed as part of the development planning and consent process. Potential impacts to the prevailing soundscape should be minimised, avoided, or mitigated to suitable levels (in accordance with current legislation, policy and guidance), avoiding an adverse impact, where possible. In addition to planning controls there is a clear trend for noise from vehicle, commercial and industrial sources to be reduced, in compliance with stricter legislation and guidance. Consequently, in relation to the project and its immediate receiving environment it is reasonable to predict a general steady baseline soundscape would be maintained.

25.8 Potential Impacts

159. This section outlines potential impacts as a result of the project and their significance, using the assessment methodology described in section 25.4 and Chapter 6 EIA Methodology. As the construction of the onshore project substation will potentially have different impacts in terms of the type and magnitude than those of the onshore cable route, the magnitude of these are discussed separately under

the same impact where relevant, however the greater of the two magnitudes is used to define the significance of that impact overall.

160. The EIA has been undertaken for the following two alternative scenarios, therefore an assessment of potential impacts has been undertaken for each scenario:

- **Scenario 1** – Norfolk Vanguard proceeds to construction and installs ducts and other shared enabling works for Norfolk Boreas.
- **Scenario 2** – Norfolk Vanguard does not proceed to construction and Norfolk Boreas proceeds alone. Norfolk Boreas undertakes all works as an independent project.

161. Where the assessment of the impact is different for Scenario 1 and Scenario 2 a separate assessment is presented under each impact heading. Where this is relevant, Scenario 2 is presented first as it would generally result in the more significant impacts.

25.8.1 Embedded Mitigation

162. Norfolk Boreas Limited has committed to a number of techniques and engineering designs/modifications as part of the project, during the pre-application phase, in order to avoid a number of impacts or reduce impacts as far as possible. Embedding mitigation into the project design is a type of primary mitigation and is an inherent aspect of the EIA process.

163. A range of different information sources has been considered as part of embedding mitigation into the design of the project (for further details see Chapter 4 Site Selection and Assessment of Alternatives, Chapter 5 Project Description, and Chapter 7 Technical Consultation) including engineering requirements, feedback from communities and landowners, ongoing discussions with stakeholders and regulators, commercial considerations and environmental best practice.

164. The following sections outline the key embedded mitigation measures relevant for this assessment. These measures are presented in Table 25.32. Where embedded mitigation measures have been developed into the design of the project with specific regard to noise and vibration, these are described in Table 25.33.

165. Note that design work for the onshore project substation is ongoing in consultation with Breckland Council. Therefore, the ES assessment provides indicative information on the level of mitigation which may be required within the final design of the onshore project substation.

Table 25.32 Embedded mitigation

Parameter	Mitigation measures embedded into the project design	Notes
Project Wide		
Commitment to HVDC technology	Commitment to HVDC technology minimises environmental impacts through the following design considerations; • HVDC requires fewer cables than the HVAC solution. During the duct installation phase this reduces the cable route working width for Norfolk Boreas to 35m from the previously identified worst case of 50m. As a result, the overall footprint of the onshore cable route required for the duct installation phase is reduced from approx. 300ha to 210ha; • The width of permanent cable easement is also reduced from 25m to 13m; • Removes the requirement for a cable relay station as permanent above ground infrastructure; • Reduces the maximum duration of the cable pulling phase from three years down to two years; • Reduces the total number of jointing pits for Norfolk Boreas from 450 to 150; and • Reduces the number of drills needed at trenchless crossings (including landfall).	Norfolk Boreas Limited has reviewed consultation received and in light of the feedback, has made a number of decisions in relation to the project design. One of these decisions is to deploy HVDC technology as the export system.
Site Selection	The project has undergone an extensive site selection process which has involved incorporating environmental considerations in collaboration with the engineering design requirements. Considerations include (but are not limited to) adhering to the Horlock Rules for onshore project substations and Necton National Grid extension and associated infrastructure, a preference for the shortest route length (where practical) and developing construction methodologies to minimise potential impacts. Key design principles from the outset were followed (wherever practical) and further refined during the EIA process, including; • Avoiding proximity to residential dwellings; • Avoiding proximity to historic buildings; • Avoiding designated sites; • Minimising impacts to local residents in relation to access to services and road usage, including footpath closures; • Utilising open agricultural land, therefore reducing road carriageway works; • Minimising requirement for complex crossing arrangements, e.g. road, river and rail crossings; • Avoiding areas of important habitat, trees, ponds and agricultural ditches; • Installing cables in flat terrain maintaining a straight route where possible for ease of pulling cables through ducts; • Avoiding other services (e.g. gas pipelines) but aiming to cross at close to right angles where crossings are required; • Minimising the number of hedgerow crossings, utilising existing gaps in field boundaries; • Avoiding rendering parcels of agricultural land inaccessible; and	Constraints mapping and sensitive site selection to avoid a number of impacts, or to reduce impacts as far as possible, is a type of primary mitigation and is an inherent aspect of the EIA process. Norfolk Boreas Limited has reviewed consultation received to inform the site selection process (including from local communities, landowners and regulators) and in response to feedback, has made a number of decisions in relation to the siting of project infrastructure. The site selection process is set out in Chapter 4 Site Selection and Assessment of Alternatives.

Parameter	Mitigation measures embedded into the project design	Notes
	• Utilising and upgrading existing accesses where possible to avoid impacting undisturbed ground.	
Long HDD at landfall	Use of long HDD at landfall to avoid restrictions or closures to Happisburgh beach and retain open access to the beach during construction. Norfolk Boreas Limited have also agreed to not use the beach car park at Happisburgh South.	Norfolk Boreas Limited has reviewed consultation received and in response to feedback, has made a number of decisions in relation to the project design. One of those decisions is to use long HDD at landfall.
Scenario 1		
Strategic approach to delivering Norfolk Boreas and Norfolk Vanguard	Under Scenario 1, onshore ducts will be installed for both projects at the same time, as part of the Norfolk Vanguard construction works. This would allow the main civil works for the cable route to be completed in one construction period and in advance of cable delivery, preventing the requirement to reopen the land in order to minimise disruption. Onshore cables would then be pulled through the pre-installed ducts in a phased approach at later stages. In accordance with the Horlock Rules, the co-location of Norfolk Boreas and Norfolk Vanguard onshore project substations will keep these developments contained within a localised area and, in so doing, will contain the extent of potential impacts.	The strategic approach to delivering Norfolk Boreas and Norfolk Vanguard in order to minimise environmental impacts has been a consideration from the outset.
Scenario 2		
Duct Installation Strategy	Under Scenario 2, the onshore cable duct installation strategy is to install ducts in sections to minimise impacts. Construction teams would work on a short section (approximately 150m length) and once the cable ducts have been installed, the section would be back filled and the top soil reinstated before moving onto the next section. This would minimise the amount of land being worked on at any one time and would also minimise the duration of works on any given section of the route.	This has been a very early project commitment. Chapter 5 Project Description provides a detailed description of the process.
Trenchless Crossings	Commitment to trenchless crossing techniques to minimise impacts to the following specific features; • Wendling Carr County Wildlife Site; • Little Wood County Wildlife Site; • Land South of Dillington Carr County Wildlife Site; • Kerdiston proposed County Wildlife Site; • Marriott's Way County Wildlife Site / Public Right of Way (PRoW); • Paston Way and Knapton Cutting County Wildlife Site; • Norfolk Coast Path; • Witton Hall Plantation along Old Hall Road;	A commitment to a number of trenchless crossings at certain sensitive locations was identified at the outset. However, Norfolk Boreas Limited has committed to certain additional trenchless crossings as

Parameter	Mitigation measures embedded into the project design	Notes
	• King's Beck; • River Wensum; • River Bure; • Wendling Beck; • Wendling Carr; • North Walsham and Dilham Canal; • Network Rail line at North Walsham that runs from Norwich to Cromer; • Mid-Norfolk Railway line at Dereham that runs from Wymondham to North Elmham; and • Trunk Roads including A47, A140, A149.	a direct response to stakeholder requests.

Table 25.33 Embedded mitigation for noise and vibration

Parameter	Embedded mitigation for noise and vibration	Notes
Operation of onshore infrastructure	The onshore infrastructure will operate and be managed by adhering to DCO requirements at the site. Applying the principles of BAT when designing the facility and for any sound emitting mobile and fixed plant. The principle of BAT ensures that suitable mitigation measures are embedded into the design and operation of the installation.	See section 25.8.6 for more details on potential impacts during operation.
Maintenance	The onshore project substation will not be permanently manned. O&M staff will visit on a regular basis (on average once per week) to carry out routine checks and maintenance. Key maintenance campaigns will take place annually. Most annual maintenance campaigns will be short (approximately 1 week), but if required some campaigns may be longer (e.g. 1-2 months). These elements represent BAT for proactive and reactive maintenance to minimise noise.	See section 25.8.6 for more details on potential impacts during operation.

25.8.2 Monitoring

166. Post-consent, the development of the detailed design for the project and the Code of Construction Practice (CoCP) will refine the worst-case impacts assessed in this ES chapter. It is recognised that monitoring is an important element in the management and verification of the actual project impacts. The requirement for, and appropriate design and scope of, monitoring will be agreed with the appropriate stakeholders and included within the final CoCP commitments (DCO Requirement 20) prior to construction works commencing. An OCoCP (document reference 8.1) has been produced and submitted as part of the DCO application.

25.8.3 Worst Case

167. Chapter 5 Project Description details the parameters of the project using the Rochdale Envelope approach for the project. This section identifies those

parameters during construction, operation and decommissioning relevant to potential impacts on noise and vibration.

168. The onshore project substation will consist of up to two HVDC converters.

169. The onshore project substation converts the HVDC electrical power from the Norfolk Boreas export connection to the High Voltage Alternating Current (HVAC) format and appropriate voltage required for connection to the national grid system. Filtering, switchgear and associated protection and control equipment is also located at the onshore project substation to provide compliance with the technical requirements of the national grid and allow safe operation of project connection.

170. For the purposes of assessing the onshore project substation, the layout consists of two similar converter stations, using worst case equipment quantities. As such, the onshore project substation will comprise:

- 2x converter buildings - housing DC filter equipment and power electronics to convert HVDC to HVAC power for connection to the national grid;
- 2x outdoor HVAC compounds – each compound will contain one or more 400kV transformers, plus HVAC filters, busbars and cable sealing ends;
- Control building – housing Supervisory Control and Data Acquisition (SCADA) and protection equipment;
- Access roads – for operation and maintenance access to equipment; and
- Associated connections between equipment via overhead busbar and cabling, including buried earthing system.

171. The largest element of equipment within the onshore project substation will be the converter halls with an approximate height of 19m, all other equipment will not exceed a height of 13m, with the exception of lightning protection masts at a height of 25m. The total land requirement for the onshore project substation to the perimeter fence is 250m x 300m.

172. A worst case approach has been incorporated throughout the assessment within the calculation methodologies, modelling and assumptions in order to present a conservative estimation of any potentially adverse effects of noise and vibration and ensure the correct level of mitigation measures are to be taken forward into the detailed design stage.

173. Under Scenario 2 during duct installation, the assessment assumes excavation of two trenches to accommodate two circuits for Norfolk Boreas.

174. Chapter 5 Project Description outlines the timings to be assessed in relation to the phasing of the works. In all cases for noise and vibration; the two phase option, where cable pulling is undertaken in two consecutive years to facilitate the commissioning of the offshore wind turbine planting, is assumed to be the worst

case. This is due to the increased length of time that receptors will be potentially impacted by the project; refer to section 25.4.1.1.

25.8.4 Assumptions and Limitations

175. Landowner access was arranged for baseline noise surveys; however, some locations where access was not agreed were subject to shorter term, attended baseline noise monitoring surveys, on publicly accessible/adjacent land where possible (identified in Appendix 25.1).

176. Following agreement with stakeholders as detailed in section 25.3, the baseline measurements collected are considered representative of the receptors identified.

25.8.4.1 Construction Assumptions

177. The following assumptions for the construction programme have been made:

- For the purposes of this assessment it was assumed construction activities would normally take place between 07:00 and 19:00 hours Monday to Friday and between 07:00 and 13:00 hours on Saturday;
- For the purposes of this assessment it was assumed that construction activities that may require 24 hour working would be during duct installation for the HDD at the landfall and at trenchless crossing zones;
- All ground was assumed to have an absorption factor of 0.6 to represent the mixed ground conditions in the area;
- All noise sources were modelled as point sources at a height of 1.5m with the exception of lorry and dump truck movements along the running track covering the extents of the whole cable search area which were modelled as moving line sources at a height of 1.5m with a 15km/h speed correction;
- Sources modelled within the duct installation scenarios have been modelled within the running track through the centre of the onshore cable route as detailed within Chapter 5 Project Description;
- Sources modelled within the pre-construction scenarios for the landfall and onshore cable route calculations have been modelled within the search area immediately adjacent to the receptor, as the running track and spoil bunds will not be constructed during this phase;
- All trenchless crossing zones (e.g. HDD) have been considered as requiring the specific plant associated with trenchless drilling operations;
- Sources within the onshore project substation footprints have been modelled approximately equidistant between nearby receptor locations;
- Residential properties were modelled as two-storey buildings at a height of 8.5m;
- Receiver levels were predicted at ground floor level (+1.5m) considered representative of daytime resting and amenity space;

- Acoustic propagation effects were calculated using the BS 5228 methodology which takes into account distance attenuation, barriers and ground absorption; and
- To present a conservative assessment it has been assumed that the National Grid substation extension will be conducted during the same time as the construction of the onshore project substation and with the same plant requirements.

178. The results of the calculation are presented as the dB $L_{Aeq, T}$ noise level in Appendix 25.2, covering the activity period highlighted in the assumptions section above, representing a conservative prediction of the noise level that might affect adjacent receptors during construction activity.

25.8.4.2 Operation Phase Assumptions

179. The following assumptions for the operation phase were made:

- All onshore assets modelled as HVDC;
- No specific noise mitigation has been embedded into the design of the electrical infrastructure;
- All sound power levels were calculated using typical sound power level data for associated plant taking source type, dimensions and relative height into consideration within calculations;
- All sources were modelled using 100% output at all times, unless otherwise stated in section 25.4.1, to present a conservative assessment;
- Residential properties were modelled as two-storey buildings at a height of 8.5m (industry standard);
- Receiver levels were predicted at ground floor (+1.5m) and 1st floor level (+4.0m) considered representative of both daytime and night time, resting and amenity space; and
- Acoustic propagation effects were calculated using the ISO 9613-2 method. The calculation methodology takes into account distance attenuation, barriers and ground absorption, air absorption, topographical screening effects and light downwind conditions from source to receptor.

180. The results of the calculations are presented as the dB $L_{Aeq, T}$ noise level covering the daytime (07:00 to 23:00 hours) and night time (23:00 to 07:00 hours) reference periods representing a conservative prediction of the noise level that might affect adjacent receptors during operation of the onshore assets.

25.8.5 Potential Impacts during Construction

181. This section presents the potential noise impacts associated with the construction of the project under both scenarios, as detailed in section 25.8. Scenario 2 is considered to present the worst case impact and is therefore presented first below.

25.8.5.1 Predicted Noise Scenario 2

182. The results of the daytime weekday (07:00 to 19:00 hours) and Saturday (07:00 to 13:00 hours) noise propagation calculations are presented in Appendix 25.2 and noise receptor locations are shown on Figure 25.2.

183. Evening and night-time calculations are also presented for the landfall area receptors as there may be the requirement to undertake construction activity over a 24 hour/7-day week programme at the landfall only, due to the HDD operations. The noise levels are based on the assumptions and approach detailed in section 25.4.

184. Additionally, evening and night-time calculations are also presented for the cable route receptors closest to the trenchless crossing works as there may be the requirement to undertake construction activity over a 24 hour/7 day week programme during trenchless crossing operations. The need to extend into longer working hours is generally dependent on locations where ground conditions are less favourable/stable and where risk to the integrity of the works may increase if left in a partially complete state overnight. Continuous, or extended working hours could also be expected at significant crossings where completing the works in one occasion is considered to reduce any risks. This is often requested at railway or major highway crossings where the asset, such as the tracks or highway surface is required not to be in use or in reduced use for the duration of the works.

185. The duration and timing of extended working hours (24 hour, seven days a week) would be agreed in advance of construction for the landfall works; it is anticipated that no HGV deliveries would access the landfall compound outside of the 7am to 7pm period (Monday to Sunday).

186. The in-combination construction phase noise impacts associated with the National Grid substation extension and the onshore project substation are considered within this section of the assessment and detailed in the relevant tables.

187. Calculated construction noise levels have been determined at the receiver floor level (GF – Ground Floor) and compared with the derived BS 5228 construction threshold noise limit for each receptor which has been derived from the measured baseline noise data contained within Appendix 25.1.

188. Impact magnitudes have been assessed in accordance with the criteria detailed Table 25.5, Table 25.6 and Table 25.7 as relevant and the significance criteria in Table 25.29.

189. It should be noted that all receptor locations fall within the BS 5228 category A threshold (in accordance with criteria detailed in Table 25.4), with the exception of CRR2, CRR8 and CRR30 which fall within the category B threshold.

190. The assessment of construction generated noise is based on worst case assumptions. It should be noted that most noisy construction activities within the onshore cable route adjacent to each respective receptor will be of relatively short duration as the active work fronts progress along the onshore cable route in 150m sections, rather than works taking place throughout the onshore area for the duration of construction. HGV and dump truck movements along the running track however, will continue throughout the construction phase.

25.8.5.1.1 Daytime noise

191. Table 25.34 summarises the potential daytime construction noise impacts at the agreed receptor locations under Scenario 2 (further details inlcuded in Appendix 25.2). Impact magnitudes have been assessed in accordance with the criteria detailed within Table 25.25 and the significance criteria detailed in Table 25.29

192. Standard construction noise mitigation techniques which could be applied in order to reduce impacts are detailed within section 25.8.5.6. In line with the conservative approach taken in this chapter and assessment, a 5dB(A) reduction only was applied to represent the effect of incorporating these mitigation measures.

193. Table 25.34 details the predicted daytime worst case construction phase noise levels at all assessed receptors (including a conservative 5dB(A) allowance for the incorporation of standard mitigation measures). Table 25.34 also includes the in-combination (worst case) predicted noise levels at receptors as a result of construction of the onshore project substation being undertaken at the same time as the constriction of the National Grid extension works. Further details for each of the construction phases are presented in sections below.

194. It should be noted that noise impacts would be short term and temporal in nature. The assessment undertaken assumes that all plant would be operating at a static location on the boundary of the works; whereas in reality, plant is likely to be more mobile within the onshore cable route.

Pre-construction

195. During pre-construction works on the onshore cable route, the magnitude of impact, after standard mitigation, was assessed as moderate to major adverse at medium

sensitivity receptors CRR1E, CRR3F, CRR10 (detailed in Table 25.34), this represents a **moderate** to **major adverse** impact. Enhanced mitigation measures will be required and are detailed in section 25.8.5.7.

196. During pre-construction works at all other receptors, the magnitude of the impact was assessed as no impact, on medium sensitivity receptors, representing a **negligible** impact.

Duct installation and primary works

197. During duct installation works on the onshore cable route the magnitude of impact, after standard mitigation, was assessed as minor to major adverse at medium sensitivity receptors CRR1E, CRR3F, CRR10 (detailed in Table 25.34), this represents **minor** to **major adverse** impacts. Enhanced mitigation measures will be required at CRR1E, CRR3F, CRR10 and are detailed in section 25.8.5.7 of this chapter.

198. During the duct installation phase at all other receptors, the magnitude of the impact was assessed as no impact, on medium sensitivity receptors, representing a **negligible** impact.

199. During the primary works phase at the onshore project substation and National Grid substation extension the magnitude of effect, after standard mitigation, was assessed as no impact at all medium sensitivity receptors; using the significance matrix detailed in Table 25.29, this represents a **negligible adverse** impact.

Cable pulling, jointing and electrical commissioning works

200. During cable pulling, jointing and commissioning works on the onshore cable route the magnitude of effect, after standard mitigation, was assessed as moderate to major adverse at medium sensitivity receptors CRR1E, CRR3F, CRR10 (detailed in Table 25.34, this represents **moderate** to **major adverse** impacts. Enhanced mitigation measures will be required and are detailed in section 25.8.5.7.

201. At the remaining onshore cable route and landfall receptors, during the cable pulling, jointing and commissioning works the magnitude of effect was assessed as no impact, at medium sensitivity receptors (shown on Figure 25.2, this represents a **negligible** impact.

202. During electrical plant installation and commissioning works at the onshore project substation and National Grid extension the magnitude of effect was assessed as no impact, at medium sensitivity receptors (shown on Figure 25.2), this represents a **negligible** impact.

Enhanced mitigation

203. Based on the worst case construction assumptions, enhanced mitigation measures will only be required at certain receptors (details of which are contained within

section 25.8.5.7 and Table 25.34). After enhanced mitigation measures are applied the noise levels would be below the BS5228 threshold resulting in a magnitude of no impact (in accordance with criteria in Table 25.5), the residual impacts at all sensitive receptors will be **negligible** using the significance matrix detailed in Table 25.29.

Table 25.34 Construction noise impacts – daytime Scenario 2

Phase	BS5228 Threshold dB(A)	Predicted noise level $L_{Aeq, 12hr}$ dB (Standard mitigation applied)	Impact Significance (Standard mitigation only)	Required Enhanced Mitigation (Yes/No) and range dB(A)	Residual Impact Significance
Landfall receptors					
Preconstruction Works	**65**	**34.8 to 50.5**	**Negligible**	No	**Negligible** with standard mitigation
Duct Installation	**65**	**41.8 to 45.3**	**Negligible**	No	**Negligible** with standard mitigation
Cable Pulling, jointing and Commissioning	**65**	**34.1 to 49.3**	**Negligible**	No	**Negligible** with standard mitigation
Onshore cable route receptors					
Preconstruction Works	**65**	**29.1 to 64.4**	**Negligible**	No	**Negligible** with standard mitigation
	70*	**46.0 to 64.4**	**Negligible**	No	**Negligible** with standard mitigation
Only 3 NSR locations where pre-construction works may result in impact which require enhanced mitigation (Threshold Category A (65) Exceeded at CRR10, CRR1E, CRR3F).	**65**	**69.0 to 76.6**	**Moderate to Major Adverse**	Yes (Noise reduction of 4.0 to 11.6 required)	**Negligible** with enhanced mitigation
Duct Installation	**65**	**36.1 to 63.3**	**Negligible**	No	**Negligible** with standard mitigation
	70*	**50.0 to 65.3**	**Negligible**	No	**Negligible** with standard mitigation
Only 3 NSR locations where duct installation works may result in impact which require enhanced mitigation Threshold Category A (65) Exceeded at CRR10, CRR1E, CRR3F).	**65**	**66.7 to 71.8**	**Minor to Major Adverse**	Yes (Noise reduction of 1.7 to 6.8 required)	**Negligible** with enhanced mitigation
Cable Pulling, jointing and Commissioning	**65**	**27.9 to 64.2**	**Negligible**	No	**Negligible** with standard mitigation

Phase	BS5228 Threshold dB(A)	Predicted noise level $L_{Aeq, 12hr}$ dB (Standard mitigation applied)	Impact Significance (Standard mitigation only)	Required Enhanced Mitigation (Yes/No) and range dB(A)	Residual Impact Significance
	70*	**44.9 to 63.6**	**Negligible**	No	**Negligible** with standard mitigation
Only 3 NSR locations where cable pulling, jointing and commissioning impacts may result in enhanced mitigation Threshold Category A (65) Exceeded at CRR10, CRR1E, CRR3F).	**65**	**68.0 to 75.0**	**Moderate to Major Adverse**	Yes (Noise reduction of 3.0 to 10.0 required)	**Negligible** with enhanced mitigation
Onshore project substation and National Grid substation extension receptors					
Preconstruction Works	**65**	**38.4 to 61.8**	**Negligible**	No	**Negligible** with standard mitigation
Preconstruction Works (In-combination with National Grid extension)	**65**	**38.5 to 61.8**	**Negligible**	No	**Negligible** with standard mitigation
Primary Works	**65**	**38.3 to 62.1**	**Negligible**	No	**Negligible** with standard mitigation
Primary Works (In-combination with National Grid extension)	**65**	**41.4 to 62.2**	**Negligible**	No	**Negligible** with standard mitigation
Electrical plant installation and commissioning including 400kv onshore cable route	**65**	**32.0 to 59.7**	**Negligible**	No	**Negligible** with standard mitigation
Electrical plant installation and commissioning including 400kv onshore cable route (In-combination with National Grid extension)	**65**	**36.3 to 59.7**	**Negligible**	No	**Negligible** with standard mitigation
Required Mitigation Key					
No additional mitigation required beyond standard CoCP measures to avoid significant adverse impacts.					
Enhanced construction mitigation techniques will be required to avoid significant adverse impact such as those detailed in section 25.8.5.7. Specific construction mitigation measures will be agreed during the detailed design stage.					

* BS 5228 category B threshold applicable to receptors CRR2, CRR8, CRR30. All other receptors category A.

25.8.5.1.2 Evening and Weekends - Landfall and Onshore Cable Route

204. There may be a requirement to undertake construction activity over a 24 hour/7-day week programme at the landfall during duct installations due to the HDD operations. Additionally, there may be the requirement to undertake construction activity over a 24 hour/7-day week programme at the trenchless crossing operations. Therefore, evening and weekend calculations are presented for the landfall and onshore cable route receptors closest to the trenchless crossing locations.

205. Table 25.35 details a summary of the potential construction noise impacts at the agreed landfall and cable route receptor locations during the evening and weekend time period. Impact magnitudes have been assessed in accordance with the criteria detailed within Table 25.6 and the significance criteria detailed in Table 25.29

206. During the evening and weekend construction period, predicted worst case noise levels at all assessed receptors (including a conservative 5dB(A) allowance for the incorporation of standard mitigation measures (detailed in section 25.8.5.6.1)) were below the BS 5228 derived thresholds.

207. In accordance with the criteria outlined in Table 25.6 , an impact magnitude of no impact was assessed at all landfall and onshore cable route receptors (which were assigned a medium sensitivity), results in a **negligible** impact significance.

Table 25.35 Construction noise impacts – evening and weekends Scenario 2

Phase	BS5228 Noise Threshold dB(A)	Predicted noise level $L_{Aeq,T}$ dB (Standard mitigation applied)	Impact Significance (Standard mitigation only)	Required Enhanced Mitigation (Yes/No) and range dB(A)	Residual Impact Significance
Landfall receptors					
Duct Installation	**55**	**39.6 to 42.7**	**Negligible**	No	**Negligible** with standard mitigation
Onshore cable route receptors					
Duct Installation	**55**	**28.8 to 54.4**	**Negligible**	No	**Negligible** with standard mitigation
	60*	**43.7 to 57.4**	**Negligible**	No	**Negligible** with standard mitigation
Required Mitigation Key					
No additional mitigation required beyond standard CoCP measures to avoid significant adverse impacts.					

* BS 5228 category B threshold applicable to receptors CRR2, CRR8, CRR30. All other receptors category A.

25.8.5.1.3 Night-time - Landfall and Onshore Cable Route

208. Table 25.36 details a summary of the potential construction noise impacts at the agreed landfall and onshore cable route receptor locations during the night time period for duct installation. Impact magnitudes have been assessed in accordance with the criteria detailed within Table 25.7 and the significance criteria detailed in Table 25.29.

209. During the night time construction period, predicted worst case noise levels at all assessed landfall receptors (including a conservative 5 dB(A) allowance for the incorporation of standard mitigation measures) were below the BS 5228 derived thresholds (shown on Figure 25.2).

210. The magnitude of impact was assessed as no impact at all the landfall receptors, this represents a **negligible** impact.

211. During the night time construction period, predicted worst case noise levels at nine assessed cable route receptors (including a conservative 5 dB(A) allowance for the incorporation of standard mitigation measures) were above the BS 5228 derived thresholds (shown on Figure 25.2).

212. Night time construction phase noise modelling was assessed at the onshore cable route during duct installation for the closest sensitive receptors to the trenchless crossings only.

213. During night time duct installation works on the onshore cable route the magnitude of impact, after standard mitigation, was assessed as negligible to major adverse at medium sensitivity receptors CRR1, CRR2, CRR3, CRR5, CRR26, CRR30, and CRR31. This represents **minor** to **major adverse** impacts. Enhanced mitigation measures will be required at CRR1, CRR2, CRR3, CRR5, CRR26, CRR30, and CRR31 in the event that night working is required and are detailed in section 25.8.5.7 of this chapter.

214. The magnitude of impact was assessed as no impact at all other assessed onshore cable route receptors, this represents a **negligible** impact.

Table 25.36 Construction noise impacts – night time Scenario 2

Phase	BS5228 Noise Threshold dB(A)	Predicted noise level $L_{Aeq, 12hr}$ dB (Standard mitigation applied)	Impact Significance (Standard mitigation only)	Required Enhanced Mitigation (Yes/No) and range dB(A)	Residual Impact Significance
Landfall receptors					
Duct Installation	**45**	**39.6 to 43.0**	**No Impact**	No	**Negligible** Impact with standard mitigation
Onshore cable route receptors					
Duct Installation	**45**	**27.9 to 43.6**	**No Impact**	No	**Negligible** Impact with standard mitigation
	50*	**44.1**	**No Impact**	No	**Negligible** Impact with standard mitigation
Only 5 NSR locations where duct installation works may result in impact which require enhanced mitigation Threshold Category A (45) Exceeded at CRR1, CRR3, CRR5, CRR26, CRR31).	**45**	**47.8 to 54.5**	**Minor to Major Adverse**	Yes (Noise reduction of 0.2 to 9.5 dBA required)	**Negligible** with enhanced mitigation
Only 2 NSR locations where duct installation works may result in impact which require enhanced mitigation Threshold Category B (50) Exceeded at CRR2, CRR30).	**50***	**57.0 to 57.5**	**Major Adverse**	Yes (Noise reduction of 7.0 to 7.5 dBA required)	**Negligible** with enhanced mitigation
Required Mitigation Key					
No additional mitigation required beyond standard CoCP measures to avoid significant adverse impacts.					
Construction mitigation techniques may be required to avoid significant adverse impact such as those detailed in section 25.8.5.7 and section 25.8.3.4. Specific construction mitigation measures will be agreed during the detailed design stage.					

* BS 5228 category B threshold applicable to receptors CRR2 and CRR30. All other receptors category A.

25.8.5.2 Road Traffic Noise Emissions Scenario 2

215. An assessment was undertaken following the methodology contained in DMRB (Volume 11, Section 3, Chapter 3) to assess whether there would be any significant changes in traffic volumes and composition on surrounding local roads as a result of the project. The significance of any predicted change in noise level was then assessed in accordance with the criteria contained in the DMRB.

216. Traffic flows and assumptions are detailed within Chapter 24 Traffic and Transport.

217. Traffic impacts were assessed for the construction phase years of 2023 and 2024 (as per the programme details in Chapter 24 Traffic and Transport), taking base flows, annual growth, Norfolk Boreas project-generated construction traffic and Hornsea Project Three generated construction traffic into consideration.

218. Relative change in ambient noise as a result of construction road traffic emissions is not expected to increase by greater than 4.9dB in either 2023 or 2024 on any associated road links. In accordance with the DMRB criteria detailed in Table 25.16, it is anticipated that project generated construction traffic will have at most a **moderate adverse** impact associated with Link 21, 25 and 69 (2023) and **moderate adverse** impact associated with Link 25 and 69 (2024), (see Appendix 25.2), with all other links experiencing a **negligible** or **minor adverse** impact.

219. Construction road traffic emissions during 2023 are anticipated to result in at most a temporary and reversible, **moderate adverse** impact at three road links (Link 21, 25 and 69), based on the medium sensitivity of the residential receptors in the vicinity of the road links.

220. Chapter 24 Traffic and Transport outlines links in the study area where there is a potential impact and introduces potential mitigation measures to reduce the severity of these impacts. A **major adverse** impact was predicted for Link 69 in the Traffic and Transport chapter. Mitigation in the form of the following was identified:

- Extend construction programme for section of the duct installation;
- Relocate the reception sides of the trenchless crossings which link 69 serves; and
- Sequential planning of construction activities to reduce peak HGV demand.

221. The traffic management measures are to be implemented through a TMP (DCO Requirement 21). Through the development of a TMP, Norfolk Boreas Limited and its contractors would engage stakeholders (detailed in Chapter 24 Traffic and Transport) to try and establish opportunities to co-ordinate activities and avoid peak traffic impacts. Using the mitigation approach defined above (i.e. reduced HGV flows by 50% or extension (doubling) of the construction programme duration) and through utilisation of the TMP, noise impacts are reduced to **minor adverse** at worse at the

three identified road links. Further details are contained within Chapter 24 Traffic and Transport.

25.8.5.3 Predicted Noise Scenario 1

222. This section presents the potential noise impacts associated with the construction of the project for Scenario 1. Under Scenario 1 the onshore cable route works are limited to the pulling of the cables through pre-installed ducts.

223. The approach and assumptions for the assessment are consistent with those for Scenario 2, please refer to section 25.8.5.1.

224. As detailed in 25.4.1.1 under Scenario 1 there are two options for the programme of landfall duct installation:

- Option A – landfall duct installation prior to cable pulling in 2024 and 2025; or
- Option B – landfall duct installation concurrently with Norfolk Vanguard in 2022 and 2023.

225. The potential noise impact associated with the landfall duct installation will be influenced by the number of HDD drilling rigs present at one time.

226. Under Option A duct installation would be consecutive, therefore the worst case is two drilling rigs undertaking works for Norfolk Boreas.

227. Under Option B, where duct installation is undertaken concurrently for Norfolk Boreas and Norfolk Vanguard, then there is the potential for either two or four drilling rigs to be working simultaneously.

25.8.5.3.1 Daytime noise

228. Table 25.37 summarises the potential daytime construction noise impacts at the agreed receptor locations under Scenario 1 (further details included in Appendix 25.2). Impact magnitudes have been assessed in accordance with the criteria detailed within Table 25.5 and the significance criteria detailed in Table 25.29.

229. Standard construction noise mitigation techniques which could be applied in order to reduce impacts are detailed within section 25.8.5.6. In line with the conservative approach taken in this chapter and assessment, a 5dB(A) reduction was applied to represent the effect of incorporating these mitigation measures.

230. It should be noted that noise impacts would be short term and temporal in nature. The assessment undertaken assumes that all plant would be operating at a static location on the boundary of the works; whereas in reality plant is likely to be more mobile within the study area.

Pre-construction

231. Under Scenario 1, during pre-construction works at the onshore project substation and at the landfall the magnitude of impact, after standard mitigation, was assessed as no impact at all receptors (detailed in Table 25.37), this represents **negligible** impact.

Duct installation at landfall

232. During the duct installation works at the landfall (Option A and Option B) the magnitude of impact, after standard mitigation, was assessed as **no impact** at all receptors, this represents a **negligible** impact.

Primary works

233. During the primary works at the onshore project substation and the National Grid substation extension the magnitude of impact, after standard mitigation, was assessed as no impact at all other receptors (detailed in Table 25.37), this represents **negligible** impact.

Cable pulling, jointing and electrical commissioning works

234. During cable pulling, jointing and commissioning works on the onshore cable route the magnitude of effect, after standard mitigation, was assessed as moderate to major adverse at medium sensitivity receptors CRR1E, CRR3F, CRR10 (detailed in Table 25.37), this represents **moderate** to **major adverse** impacts. Enhanced mitigation measures will be required and are detailed in section 25.8.5.7 of this chapter.

235. At all other onshore cable route receptors and the landfall receptors the magnitude of the impact was assessed as no impact, on a medium sensitivity receptor, representing a **negligible** impact.

236. During electrical plant installation and commissioning works at the onshore project substation and National Grid substation extension the magnitude of impact, after standard mitigation, was assessed as no impact at all receptors (detailed in Table 25.37, this represents a **negligible impact**.

Enhanced mitigation

237. Based on the worst case construction assumptions, enhanced mitigation measures will only be required at CRR1E, CRR3F, CRR10,during the cable pulling works on the onshore cable route (details of which are contained within section 25.8.5.7 and Table 25.37). After enhanced mitigation measures are applied noise levels would be below the BS5228 threshold resulting in a magnitude of no impact (in accordance with criteria in Table 25.6) and the residual impacts at all sensitive receptors will be **negligible**.

Table 25.37 Construction noise impacts – daytime Scenario 1

Phase	BS5228 Threshold dB(A)	Predicted noise level $L_{Aeq, 12hr}$ dB (Standard mitigation applied)	Impact Significance (Standard mitigation only)	Required Enhanced Mitigation (Yes/No) and range dB(A)	Residual Impact Significance
Landfall receptors					
Preconstruction Works	**65**	**34.8 to 50.5**	**Negligible**	No	**Negligible** with standard mitigation
Duct Installation Works Option A – 2 drills in landfall compound (NB Only)	**65**	**39.5 to 42.7**	**Negligible**	No	**Negligible** with standard mitigation
Duct Installation Works Option B – 1 drill per landfall compound (NV and NB)	**65**	**42.7 to 46.0**	**Negligible**	No	**Negligible** with standard mitigation
Duct Installation Works Option B – 2 drills per compound (NV and NB)	**65**	**43.2 to 46.5**	**Negligible**	No	**Negligible** with standard mitigation
Cable Pulling, jointing and commissioning	**65**	**34.1 to 49.3**	**Negligible**	No	**Negligible** with standard mitigation
Onshore cable route receptors					
Cable Pulling, jointing and commissioning	**65**	**27.9 to 64.2**	**Negligible**	No	**Negligible** with standard mitigation
	70*	**44.9 to 63.6**	**Negligible**	No	**Negligible** with standard mitigation
Only 3 NSR locations where Cable Pulling, jointing and commissioning impacts may result in enhanced mitigation Threshold Category A (65) Exceeded at CRR10, CRR1E, CRR3F).	**65**	**68.0 to 75.0**	**Moderate to Major Adverse**	Yes (Noise reduction of 3.0dBA to 10.0dBA required)	**Negligible** with enhanced mitigation
Onshore project substation and National Grid substation extension receptors					
Preconstruction Works	**65**	**30.5 to 57.7**	**Negligible**	No	**Negligible** with standard mitigation
Primary Works	**65**	**27.3 to 43.2**	**Negligible**	No	**Negligible** with standard mitigation
Electrical plant installation and commissioning	**65**	**32.0 to 60.6**	**Negligible**	No	**Negligible** with standard mitigation

Phase	BS5228 Threshold dB(A)	Predicted noise level $L_{Aeq, 12hr}$ dB (Standard mitigation applied)	Impact Significance (Standard mitigation only)	Required Enhanced Mitigation (Yes/No) and range dB(A)	Residual Impact Significance
Required Mitigation Key					
No additional mitigation required beyond standard CoCP measures to avoid significant adverse impacts.					
Construction mitigation techniques will be required to avoid significant adverse impact such as those detailed in section 25.8.5.7. Specific construction mitigation measures will be agreed during the detailed design stage.					

* BS 5228 category B threshold applicable to receptors CRR2, CRR8, CRR30. All other receptors category A.

25.8.5.3.2 Evening and Weekends - Landfall

238. There may be the requirement to undertake construction activity over a 24 hour/7 day week programme at the landfall during duct installation for the long HDD operations. Table 25.38 details a summary of the potential construction noise impacts at the agreed landfall receptor locations during the evening and weekend time period. Impact magnitudes have been assessed in accordance with the criteria detailed within Table 25.6 and the significance criteria detailed in Table 25.29.

239. During the evening and weekend construction period, predicted worst case noise levels at all assessed receptors (including a conservative 5dB(A) allowance for the incorporation of standard mitigation measures (detailed in section 25.8.5.6) were below the BS 5228 derived thresholds.

240. The magnitude of effect was assessed as no impact at all landfall receptors which were assigned a medium sensitivity, this results in a **negligible** impact.

Table 25.38 Construction noise impacts – evening and weekends Scenario 1

Phase	BS5228 Threshold dB(A)	Predicted noise level $L_{Aeq, T}$ dB (Standard mitigation applied)	Impact Significance (Standard mitigation only)	Required Enhanced Mitigation (Yes/No) and range dB(A)	Residual Impact Significance
Landfall receptors					
Duct Installation Works Option A – 2 drills in landfall compound (NB Only)	**55**	**39.5 to 42.7**	**Negligible**	No	**Negligible** with standard mitigation
Duct Installation Works Option B – 1 drill per landfall compound (NV and NB)	**55**	**42.7 to 46.0**	**Negligible**	No	**Negligible** with standard mitigation

Phase	BS5228 Threshold dB(A)	Predicted noise level $L_{Aeq,T}$ dB (Standard mitigation applied)	Impact Significance (Standard mitigation only)	Required Enhanced Mitigation (Yes/No) and range dB(A)	Residual Impact Significance
Duct Installation Works Option B – 2 drills per compound (NV and NB)	**55**	**43.2 to 46.5**	**Negligible**	No	**Negligible** with standard mitigation
Required Mitigation Key					
No additional mitigation required beyond standard CoCP measures to avoid significant adverse impacts.					

25.8.5.3.3 Night-time - Landfall

241. Table 25.39 details a summary of the potential construction noise impacts at the agreed landfall receptors during the night time period during HDD duct installation. Impact magnitudes have been assessed in accordance with the criteria detailed within Table 25.7 and the significance criteria detailed in Table 25.29.

242. During the night time construction period, predicted worst case noise levels at all assessed receptors (including a conservative 5dB(A) allowance for the incorporation of standard mitigation measures) were below the BS 5228 derived thresholds, with the exception of receptor LFR2H (shown on Figure 25.2).

243. The magnitude of effect was assessed as no impact at all landfall receptors (medium sensitivity) under Option A (Norfolk Boreas only) and at all receptors except LFR2H under Option B, this represents a **negligible** impact.

244. The magnitude of impact at LFR2H (medium sensitivity) was assessed as a minor adverse impact during duct installation under Option B (Norfolk Boreas and Norfolk Vanguard concurrent installation), this represents a **minor adverse** impact.

245. Based on the worst case construction phase assumptions, enhanced mitigation measures will only be required at this receptor under Option B (details of which are contained within section 25.8.5.7). The residual impact after enhanced mitigation measures are applied will be negligible, resulting in a **negligible** impact.

Table 25.39 Construction noise impacts – night time Scenario 1

Phase	BS5228 Threshold dB(A)	Predicted noise level $L_{Aeq,T}$ dB (Standard mitigation applied)	Impact Significance (Standard mitigation only)	Required Enhanced Mitigation (Yes/No) and range dB(A)	Residual Impact Significance
Landfall receptors					
Duct Installation Works Option A – 2 drills in landfall compound (NB Only)	**45**	**39.5 to 42.7**	**Negligible**	No	**Negligible** with standard mitigation
Duct Installation Works Option B – 1 drill per landfall compound (NV and NB)	**45**	**42.7 to 43.8**	**Negligible**	No	**Negligible** with standard mitigation
Only 1 NSR location where Duct Installation impacts may result in enhanced mitigation (Threshold Category A (45) Exceeded at LFR2H).	**45**	**46.0**	**Minor**	Yes (Noise reduction of 1.0dBA required)	**Negligible** with standard mitigation
Duct Installation Works Option B – 2 drills per compound (NV and NB)	**45**	**43.2 to 44.2**	**Negligible**	No	**Negligible** with standard mitigation
Only 1 NSR location where Duct Installation impacts may result in enhanced mitigation (Threshold Category A (45) Exceeded at LFR2H).	**45**	**46.5**	**Minor**	Yes (Noise reduction of 1.5dBA required)	**Negligible** with standard mitigation
Required Mitigation Key					
No additional mitigation required beyond standard CoCP measures to avoid significant adverse impacts.					
Construction mitigation techniques will be required to avoid significant adverse impact such as those detailed in section 25.8.5.7. Specific construction mitigation measures will be agreed during the detailed design stage.					

25.8.5.4 Road Traffic Noise Emissions Scenario 1

246. An assessment was undertaken following the methodology contained in DMRB (Volume 11, Section 3, Chapter 3) to assess whether there would be any significant changes in traffic volumes and composition on surrounding local roads as a result of the project. The significance of any predicted change in noise level was then assessed in accordance with the criteria contained in the DMRB.

247. Traffic flows and assumptions are detailed within Chapter 24 Traffic and Transport.

248. Traffic impacts were assessed for the construction phase years of 2026 and 2027 as these years have been identified as the worst case traffic flows during all onshore construction works under Scenario 1 (as per the details in Chapter 24 Traffic and Transport), taking base flows, annual growth and project-generated construction traffic into consideration.

249. Relative change in ambient noise as a result of construction road traffic emissions is not expected to increase by greater than +2.1dB in either 2026 or 2027 on any associated road links. In accordance with the DMRB criteria detailed in Table 25.16, it is anticipated that project generated construction traffic will have at most a **minor adverse** impact (see Appendix 25.2), with all links experiencing **negligible** or **minor** impacts.

250. Construction road traffic emissions are anticipated to result in at most a temporary and reversible, **minor adverse** impact at 108 road links, in accordance with the impact significance matrix detailed in Table 25.29, and based on the medium sensitivity of the residential receptors in the vicinity of the road links.

251. Chapter 24 Traffic and Transport outlines the traffic management measures to be implemented through a TMP (DCO Requirement 21). Through the development of a TMP, Norfolk Boreas Limited and its Contractors would engage stakeholders to try and establish opportunities to co-ordinate activities and avoid peak traffic impacts. Further details are contained within Chapter 24 Traffic and Transport.

25.8.5.5 Vibration

252. The potential for vibration impact is considered to be the same under each scenario, with the exception of trenchless crossings required under Scenario 2; therefore, it is prudent to assess the impact of each scenario together in one section.

253. It is understood that piling would only be required as a worst case, depending on ground conditions, for construction of the onshore project substation, the installation of the new overhead line towers adjacent to the National Grid substation extension and potentially at landfall and trenchless crossing zones (Scenario 2 only) to temporarily anchor the drilling rigs along the onshore cable route.

254. The closest receptor locations to the onshore project substation are SSR2 and SSR4 which are approximately 750m away. In accordance with Table 25.18, at a setback distance of 750m it is considered that any vibration levels would not be perceptible at receptor locations.

255. The closest receptor location to the overhead line modifications temporary works area is SSR5 which is approximately 230m away. In accordance with Table 25.18, at a setback distance of 230m it is unlikely that any vibration levels attributed to piling would be perceptible at receptor locations. HGV movements on uneven haul routes

at this distance might induce a PPV of 0.3mm/s at the receptor; however, it is unlikely that this will result in any perceived vibration impact at the receptor due to its relative proximity to the A47 which already experiences high levels of traffic.

256. All representative receptor locations are shown on Figure 25.2.

257. Other sources of vibration such as HGV movements on uneven haul routes may be perceptible at receptor locations in the vicinity of the onshore cable route and at the landfall.

258. HGV activity within the site would rarely be at the site boundary for any extended period, and given the proximity of receptors to adjacent roads, along with the expected running track, noise management controls, and restricted vehicle speeds, this activity would not be expected to generate vibration effects at receptor locations in the vicinity of the project.

259. Construction modelling along the onshore cable route assumed that all plant was located at the closest point to each sensitive receptor. At this stage the exact location of works is not known and any piling required at trenchless crossing zones (e.g. HDD) and landfall will need to be located subject to vibration criteria.

260. In order to prevent cosmetic damage to buildings in the vicinity of the works priority should be given to piling methods which minimise vibration i.e. augered piling (subject to suitable ground conditions). Table 25.19 details indicative vibration levels from various piling methods with regards to buildings of differing architectural merit.

261. In order to prevent significant adverse impacts from vibration (relating to human perceptibility) percussive piling, for example, should not be conducted within 18m of any sensitive receptor location. Piling is 230m from the nearest receptors representing a no impact magnitude; for a medium sensitivity receptor (using the significance matrix detailed in Table 25.29), this represents a **negligible** impact.

25.8.5.6 Standard Mitigation

262. Standard construction noise mitigation practices and good practice construction management will be adopted throughout the construction phase. These will be captured within a Construction Noise Management Plan (CNMP) which forms part of the Code of Construction Practice (CoCP) (DCO Requirement 21) an outline of which (document reference 8.1) has been submitted as part of the DCO application. A summary of the measures is set out in the following sections.

25.8.5.6.1 Construction Noise Management Plan

263. The Control of Pollution Act and BS 5228 define a set of Best Practice working methods and mitigation measures, referred to as BPM. Examples of these measures include:

- Where possible, locating temporary plant so that it is screened from receptors by on-site structures, such as site cabins;
- Using modern, quiet equipment and ensuring such equipment is properly maintained and operated by trained staff;
- Applying enclosures to particularly noisy equipment where possible;
- Ensuring that mobile plant is well maintained such that loose body fittings or exhausts do not rattle or vibrate;
- Ensuring plant machinery is turned off when not in use;
- Providing local residents with 24 hour contact details for a site representative in the event that disturbance due to noise from the construction works is perceived; and
- Establishing a community engagement process including informing local residents about the construction works, detailing the timing and duration of any particularly noisy elements, and providing a contact telephone number to them;
- Keeping noisy deliveries to the middle of the day where possible.

264. Although the effect of adopting such methods cannot be precisely quantified, these methods are considered to typically reduce noise levels by between 5 – 10 dB(A). In order to provide a conservative approach, the construction phase assessment has assumed a 5dB(A) reduction for incorporating these mitigation measures.

Training of construction staff

265. The site induction programme and site rules should include good working practice instructions for site staff, managers, visitors and contractors to help minimise noise whilst working on the site.

266. Good working practice guidelines/instructions could include, but not be limited to, the following points:

- Avoiding unnecessary revving of engines;
- Plant used intermittently should be shut-down between operational periods, where possible;
- Avoiding reversing wherever possible;
- Reporting any defective equipment/plant as soon as possible so that corrective maintenance can be undertaken; and
- Handling material in a manner that minimises noise.

Maintenance of construction plant

267. Maintenance of temporary plant should be carried out routinely and in accordance with the manufacturers' guidance.

268. A regular inspection of all plant and equipment should be undertaken to ensure that:

- All plant is in a good state of repair and fully functional;

- Any plant found to be requiring interim maintenance has been identified and taken out of use;
- Acoustic enclosures fitted to plant are in a good state of repair;
- Doors and covers to such enclosures remain closed during operation; and
- Any repairs are being undertaken by a fully qualified maintenance engineer.

25.8.5.7 Enhanced Mitigation

25.8.5.7.1 Localised screening/temporary noise barriers

269. During the daytime period (Scenario 2), the predicted impact significance (including standard mitigation) at onshore cable route receptors CRR1E, CRR3F and CRR10 during pre-construction works were **moderate** to **major adverse**; at CRR1E, CRR3F, CRR10 during duct installation works were **minor** to **major adverse**; and at CRR1E, CRR3F, CRR10 during cable pulling, jointing and commissioning were **moderate** to **major adverse**.

270. During the night-time period (Scenario 2), the predicted impact significance (including standard mitigation) at onshore cable route receptors CRR1, CRR2, CRR3, CRR5, CRR26, CRR30 and CRR31 during duct installation works at trenchless crossings were **minor** to **major adverse**.

271. During the daytime period (Scenario 1), the predicted impact significance (including standard mitigation) at onshore cable route receptors CRR1E, CRR3F and CRR10 during cable pulling, jointing and commissioning were **moderate** to **major adverse**.

272. For the landfall duct installation works, receptor LFR2H was predicted to be a **minor adverse** impact significance during the night time period only (Scenario 1 Option B and Scenario 2).

273. In order to ensure these impacts are mitigated as far as reasonably possible, the aforementioned standard mitigation will be augmented by a suite of enhanced mitigation measures. The detail of the enhanced mitigation measures will be drawn up and agreed as part of the CNMP.

274. The enhanced mitigation measures will include the selection and deployment of particularly low noise plant near the identified receptors. It is also likely that the use of noise barriers and the use of temporary bunds would be suitable mitigation measures to reduce the residual noise levels of a **negligible** impact as defined in significance matrix Table 25.29.

275. Norfolk Boreas are committed to a continuing dialogue with affected communities and stakeholders. Through well informed consultation we are confident that the agreement and implementation of the detailed CNMP will deliver the noise

reduction required to ensure the construction of Norfolk Boreas results in now more than a **negligible** noise impact

25.8.5.7.2 Use of Noise barriers as Enhanced Mitigation

276. The use of noise barriers is well tried and documented mitigation measure to reduce noise impacts at receptor locations. As an example of the relative effectiveness of applying a temporary localised noise barrier BS 5228 states:

> *"as a working approximation, if there is a barrier or other topographic feature between the source and the receiving position, assume an approximate attenuation of 5 dB when the top of the plant is just visible to the receiver over the noise barrier, and of 10 dB when the noise screen completely hides the sources from the receiver. High topographical features and specifically designed and positioned noise barriers could provide greater attenuation."*

25.8.5.7.3 Use of Construction plant selection as Enhanced Mitigation

277. During the daytime construction period, bulldozers, dump trucks and tracked excavators have been identified as the noisiest sources at receptor locations within the onshore cable route where major adverse impacts have been predicted.

278. During the night time construction period, drilling rigs, generators and backhoe loaders have been identified as the noisiest sources at receptor locations within the onshore cable route where minor to major adverse impacts have been predicted.

279. Careful scrutiny of plant selection at procurement stage would ensure that the associated noise impact of the aforementioned plant is reduced as much as reasonably possible.

280. Initial calculations determined that with the application of standard mitigation measures as detailed in section 25.8.5.6 and an increased separation distance from the noisiest mobile and stationary plant, would ensure that the BS 5228 daytime construction noise thresholds are not exceeded at CRR1E, CRR3F, CRR10.

281. With the incorporation of enhanced mitigation measures, it is predicted that the magnitude of impact will reduce to no impact for all medium sensitivity receptors during all phases of construction; using the significance matrix detailed in Table 25.29, this represents a **negligible** impact.

25.8.6 Potential Impacts during Operation

282. This section presents a worst case overview of potential noise impacts associated with the operation of the onshore infrastructure. The only onshore operational noise sources associated with the project are expected to be from the onshore

project substation under each scenario. To be consistent with the construction phase assessment, Scenario 2 is presented first. However, in the operational phase, Scenario 1 is considered to have a greater potential impact due to additional onshore infrastructure associated with Norfolk Vanguard.

25.8.6.1 Predicted noise

283. SoundPLAN noise modelling software was utilised to predict noise from the normal anticipated site operational aspects of the project. Operations are proposed 24 hours a day at the onshore project substation.

284. The impact assessment has been undertaken using the unmitigated worst case scenario for the potential components that could be used at the onshore project substation. The aim of this worst case assessment is to inform the design of mitigation that may be required to ensure the project can be operated without causing a significant impact on the noise environment of communities around them.

285. BS 4142 is considered suitable for the assessment of sound of an industrial or commercial nature impacting on residential premises. The soundscape within the vicinity of the receptor locations around the onshore project substation is dominated principally by road traffic noise from the A47.

286. Calculated operational noise levels have been determined at GF – Ground Floor and 1st Floor levels and compared with the background noise levels at each receptor, which have been derived from the measured baseline noise data contained within Appendix 25.1.

287. The magnitude of effects has been assessed in accordance with BS 4142:2014 derived thresholds, detailed within Table 25.21, and the significance criteria detailed in Table 25.29.

- An assessment of the 35 dB(A) condition and 32 dB(Z) 100Hz 1/3 octave band condition (outlined in section 25.4 of this chapter) has also been included, which represents the permitted noise levels of the existing Dudgeon substation.

25.8.6.1.1 Scenario 2

288. The onshore project substation footprint is defined in Figure 25.1 and the SoundPLAN modelling was based on locating the infrastructure at this location.

289. Table 25.40 contains a summary of the potential unmitigated operational noise impacts for Scenario 2, associated with the onshore project substation at the agreed NSRs. No BS 4142:2014-character penalties have been applied.

290. A contour isopleth showing the predicted unmitigated operational noise from Norfolk Boreas in Scenario 2 is detailed in Appendix 25.3, Plate 3.2.

291. Table 25.40 details the assessment for Scenario 2 (using the updated component data provided by the onshore project substation supply chain) shows that the onshore project substation in isolation (without the application of additional noise mitigation measures) will fall within the 32dB(Z) 100hz limit at all receptors.

292. At receptor SSR2 and SSR10 effects of negligible and moderate negligible magnitude, respectively, were determined in accordance with BS 4142:2014 derived impact magnitudes. Using the significance matrix detailed in Table 25.29, SSR2 and SRR10, (medium sensitivity receptors), a **minor adverse** and **moderate adverse** impact are predicted respectively. For all other assessed receptors, a magnitude of no impact is predicted resulting in a **negligible** impact significance.

Table 25.40 Norfolk Boreas worst case operational noise impacts - Scenario 2 unmitigated

NSR	Floor	Onshore Project Substation Noise Level Contribution at Receptor		Background Noise Level at Receptor L_{A90} [dB(A)]		BS4142 derived Impact Magnitude	100Hz [dB(Z)] Condition Compliance (Yes/No)
		Broadband [dB(A)]	100Hz [dB(Z)]	Daytime	Night Time		
SSR1	GF (Ground Floor)	20.6	24.2	37.7	33.8	No Impact	Yes
	FF (First Floor)	21.9	24.2	37.7	33.8	No Impact	Yes
SSR2	GF	28.9	30.8	32.2	28.4	Negligible	Yes
	FF	31.2	31.0	32.2	28.4	Negligible	Yes
SSR3	GF	21.7	25.1	32.2	28.4	No Impact	Yes
	FF	23.3	25.4	32.2	28.4	No Impact	Yes
SSR4	GF	21.0	30.2	31.0	22.9	No Impact	Yes
	FF	21.9	30.4	31.0	22.9	No Impact	Yes
SSR5	GF	23.0	25.9	50.5	29.9	No Impact	Yes
	FF	25.4	26.6	50.5	29.9	No Impact	Yes
SSR6	GF	13.5	23.4	36.0	28.6	No Impact	Yes
	FF	14.6	23.5	36.0	28.6	No Impact	Yes
SSR7	GF	24.3	29.1	46.3	39.4	No Impact	Yes
	FF	25.0	29.3	46.3	39.4	No Impact	Yes
SSR8	GF	19.2	26.1	58.4	36.8	No Impact	Yes

NSR	Floor	Onshore Project Substation Noise Level Contribution at Receptor		Background Noise Level at Receptor L_{A90} [dB(A)]		BS4142 derived Impact Magnitude	100Hz [dB(Z)] Condition Compliance (Yes/No)
		Broadband [dB(A)]	100Hz [dB(Z)]	Daytime	Night Time		
	FF	20.3	26.3	58.4	36.8	No Impact	Yes
SSR9	GF	15.9	24.2	36.5	32.2	No Impact	Yes
	FF	16.5	24.3	36.5	32.2	No Impact	Yes
SSR10	GF	26.9	29.6	34.0	21.8	Moderate	Yes
	FF	27.6	29.6	34.0	21.8	Moderate	Yes
SSR11	GF	23.7	26.4	56.5	31.3	No Impact	Yes
	FF	25.2	27.1	56.5	31.3	No Impact	Yes
		BS4142 Criteria Met or 32dBZ 100Hz Requirement Met					
		BS4142 Criteria Exceeded or 32dBZ 100Hz Requirement Exceeded					

25.8.6.1.2 Scenario 1

293. The onshore project substation footprint will be located adjacent to the Norfolk Vanguard onshore project substation (refer to Figure 25.1).

294. Table 25.41 contains a summary of the potential unmitigated operational noise impacts for Scenario 1, associated with the onshore project infrastructure at the agreed receptor locations. No BS 4142:2014 character penalties have been applied.

295. Scenario 1 assumes the Norfolk Vanguard onshore substation and Dudgeon substation are fully operational and mitigated (where necessary) to achieve the required planning conditions as detailed in paragraph 109 and paragraph 299, and as such have been included as part of the noise assessment.

296. A contour isopleth showing the predicted unmitigated operational noise from Norfolk Boreas is detailed in Appendix 25.3, Plate 3.4.

297. Table 25.41 details the assessment for Scenario 1 (using the updated component data provided by the onshore project substation supply chain) which shows that the Norfolk Boreas onshore project substation (without the application of additional noise mitigation measures) in combination with Norfolk Vanguard (mitigated) will fall within the 32dB(Z) 100hz limit at all receptors.

298. At receptors SSR2 and SSR10 effects of and negligible and moderate magnitude, respectively, were identified in accordance with BS 4142:2014 derived impact magnitudes. Using the significance matrix detailed in Table 25.29, at SSR2 and SSR10, (medium sensitivity receptors), a **minor adverse** and **moderate adverse** impact are predicted respectively. For all other assessed receptors, a magnitude of no impact is predicted resulting in a **negligible** impact significance.

Table 25.41 Norfolk Boreas worst case operational noise impacts - Scenario 1 Norfolk Boreas unmitigated

NSR	Floor	Onshore Project Substation Noise Level Contribution at Receptor		Background Noise Level at Receptor L_{A90} [dB(A)]		BS4142 derived Impact Magnitude	100Hz [dB(Z)] Condition Compliance (Yes/No)
		Broadband [dB(A)]	100Hz [dB(Z)]	Daytime	Night Time		
SSR1	GF (Ground Floor)	20.4	26.4	37.7	33.8	No Impact	Yes
	FF (First Floor)	21.7	26.1	37.7	33.8	No Impact	Yes
SSR2	GF	29.7	32.5	32.2	28.4	Negligible	Yes
	FF	30.8	32.9	32.2	28.4	Negligible	Yes
SSR3	GF	22.4	27.1	32.2	28.4	No Impact	Yes
	FF	24.1	27.4	32.2	28.4	No Impact	Yes
SSR4	GF	21.7	32.0	31.0	22.9	No Impact	Yes
	FF	22.4	32.2	31.0	22.9	No Impact	Yes
SSR5	GF	21.3	27.6	50.5	29.9	No Impact	Yes
	FF	22.4	28.1	50.5	29.9	No Impact	Yes
SSR6	GF	14.8	25.4	36.0	28.6	No Impact	Yes
	FF	15.6	25.5	36.0	28.6	No Impact	Yes
SSR7	GF	23.8	31.7	46.3	39.4	No Impact	Yes
	FF	24.4	32.0	46.3	39.4	No Impact	Yes
SSR8	GF	20.6	28.5	58.4	36.8	No Impact	Yes
	FF	21.7	28.6	58.4	36.8	No Impact	Yes
SSR9	GF	16.0	26.2	36.5	32.2	No Impact	Yes
	FF	16.6	26.4	36.5	32.2	No Impact	Yes

NSR	Floor	Onshore Project Substation Noise Level Contribution at Receptor		Background Noise Level at Receptor L_{A90} [dB(A)]		BS4142 derived Impact Magnitude	100Hz [dB(Z)] Condition Compliance (Yes/No)
		Broadband [dB(A)]	100Hz [dB(Z)]	Daytime	Night Time		
SSR10	GF	27.9	31.7	34.0	21.8	Moderate	Yes
	FF	28.8	31.8	34.0	21.8	Moderate	Yes
SSR11	GF	23.0	28.1	56.5	31.3	No Impact	Yes
	FF	24.4	28.7	56.5	31.3	No Impact	Yes
		BS4142 Criteria Met or 32dBZ 100Hz Requirement Met					
		BS4142 Criteria Exceeded or 32dBZ 100Hz Requirement Exceeded					

25.8.6.2 Mitigation

299. The magnitude of effect has been assessed in accordance with BS 4142:2014 derived thresholds. The results of the modelling will inform the detailed design of the onshore project substation post-consent. Commitments relating to operational noise will be secured through the DCO. Suitable mitigation measures will be identified to deliver the required noise reduction to ensure that noise emissions will not exceed the cumulative noise levels already permitted at this location, specifically:

- The noise rating level (defined as set out in BS 4142) from the operation of the substation shall not exceed 35 dB $L_{Aeq,\ (5\ minutes)}$ at any time at a free field location immediately adjacent to any noise sensitive location; and
- Noise from the operation of the substation shall not exceed a limit value of 32 dB $L_{Leq\ (15\ minutes)}$ in the 100 Hz third octave band, at any time at a free field location immediately adjacent to any noise sensitive location.

300. It should be noted the noise source data and assumptions are conservative for the purposes of a worst case assessment and that mitigation could be as simple as procuring or specifying equipment with lower noise outputs (depending on technological and engineering capabilities) than the worst case that has been assessed here.

301. This assessment provides indicative information on the level of mitigation which would be required within the final design of the onshore project substation (to be addressed at detailed design stage).

302. Norfolk Boreas Limited has committed to providing a final design of the project which is able to meet the rigorous standards of low noise emissions expected by both the UK regulatory bodies and stakeholders. Noise reduction technology and design approach is discussed below and there are many proven mitigation options that, through the detailed design process, can be combined to create a design that will meet the required low noise emissions.

303. Investigative noise modelling has identified the autotransformers and harmonic filter reactors as being the dominant noise sources in terms of both broadband [dB(A)] and 100Hz [dB(Z)] noise contributions at nearby sensitive receptors. Table 25.42 details the performance requirement for an example of suitable mitigation (acoustic enclosure/shielding) which would result in compliance with the requirements (conditions) referred to above.

304. This mitigation solution has been taken from commercially available literature. It is an example from one of many available suppliers who are able to provide such solutions and the designs are in keeping with the models presented as part of the Landscape and Visual Impact Assessment (see Chapter 29). The mitigation performance modelled here is based on a conservative application of the onshore project substation noise mitigation techniques and technologies which are readily available today.

Table 25.42 Operational noise mitigation

	Noise Attenuation (dB) Performance			
	Harmonic Filter Reactor Mitigation		Autotransformer Mitigation	
Frequency (Hz)	**1/3 Octave Band**	**1/1 Octave Band**	**1/3 Octave Band**	**1/1 Octave Band**
50	14.8	-	-	-
63	7.1	20.0	-	-
80	18.1	-	-	-
100	29.5	-	23.3	-
125	33.9	35.6	29.3	37.5
160	24.4	-	36.6	-
200	33.7	-	38.5	-
250	37.3	40.0	43.2	48.2
315	33.7	-	45.8	-
400	37.8	-	48.4	-

	Noise Attenuation (dB) Performance			
	Harmonic Filter Reactor Mitigation		Autotransformer Mitigation	
Frequency (Hz)	**1/3 Octave Band**	**1/1 Octave Band**	**1/3 Octave Band**	**1/1 Octave Band**
500	37.6	41.7	51.7	56.7
630	35.0	-	54.0	-
800	36.1	-	55.1	-
1000	41.5	44.4	57.4	62.6
1250	39.7	-	59.8	-
1600	42.4	-	63.1	-
2000	42.2	47.8	66.7	72.9
2500	44.1	-	71.0	-
3150	45.0	-	73.2	-
4000	44.1	48.7	73.5	77.5
5000	42.3	-	71.1	-
Sum	Rw (C;Ctr) = 40 (-1; -3) dB		Rw (C;Ctr) = 52 (-3; -10) dB	

305. Table 25.43 detail the results of the mitigated modelling exercise for Scenario 2, which shows that the onshore project substation, with the application of additional noise mitigation measures will fall within the 32dB(Z) 100hz condition limit and also results in no impact at identified receptor locations in accordance with BS 4142:2014 derived impact magnitudes. Therefore, using the significance matrix detailed in Table 25.29, at all sensitive onshore project substation receptors, a **negligible** impact is predicted.

306. A contour isopleth showing the predicted mitigated operational noise from Norfolk Boreas is detailed in Appendix 25.3, Plate 3.3.

Table 25.43 Mitigated operational noise impacts – Scenario 2

NSR	Floor	Onshore Project Substation Noise Level Contribution at Receptor		Background Noise Level at Receptor L_{A90} [dB(A)]		BS4142 derived Impact Magnitude	100Hz [dB(Z)] Condition Compliance (Yes/No)
		Broadband [dB(A)]	100Hz [dB(Z)]	Daytime	Night Time		
SSR1	GF (Ground Floor)	10.0	21.7	37.7	33.8	No Impact	Yes
	FF (First Floor)	10.9	21.8	37.7	33.8	No Impact	Yes
SSR2	GF	17.1	28.1	32.2	28.4	No Impact	Yes
	FF	18.4	28.5	32.2	28.4	No Impact	Yes
SSR3	GF	10.2	22.5	32.2	28.4	No Impact	Yes
	FF	11.4	22.8	32.2	28.4	No Impact	Yes
SSR4	GF	14.9	28.0	31.0	22.9	No Impact	Yes
	FF	15.6	28.2	31.0	22.9	No Impact	Yes
SSR5	GF	11.1	23.4	50.5	29.9	No Impact	Yes
	FF	13.0	24.1	50.5	29.9	No Impact	Yes
SSR6	GF	7.8	21.2	36.0	28.6	No Impact	Yes
	FF	8.2	21.2	36.0	28.6	No Impact	Yes
SSR7	GF	15.0	27.8	46.3	39.4	No Impact	Yes
	FF	15.5	28.1	46.3	39.4	No Impact	Yes
SSR8	GF	11.2	24.4	58.4	36.8	No Impact	Yes
	FF	11.8	24.6	58.4	36.8	No Impact	Yes
SSR9	GF	9.0	22.4	36.5	32.2	No Impact	Yes
	FF	9.4	22.4	36.5	32.2	No Impact	Yes
SSR10	GF	16.0	27.0	34.0	21.8	No Impact	Yes
	FF	16.7	27.0	34.0	21.8	No Impact	Yes
SSR11	GF	12.7	24.5	56.5	31.3	No Impact	Yes
	FF	14.0	25.1	56.5	31.3	No Impact	Yes
		BS 4142 Criteria Met or 32 dBZ 100 Hz Requirement Met					

307. Table 25.44 details the results of the mitigated modelling exercise for Scenario 1, which shows that the Norfolk Boreas onshore project substation, with the application of additional noise mitigation measures (and the mitigated operational Norfolk Vanguard onshore substation) will fall within the 32 dB(Z) 100 Hz condition limit and also results in no impact at identified receptor locations in accordance with BS4142:2014 derived impact magnitudes. Therefore, using the significance matrix detailed in Table 25.29, at all sensitive onshore project substation receptors, a **negligible** impact is predicted.

308. A contour isopleth showing the predicted mitigated operational noise from Norfolk Boreas and Norfolk Vanguard is detailed in Appendix 25.3, Plate 3.5.

Table 25.44 Mitigated operational noise impacts – Scenario 1

NSR	Floor	Onshore Project Substation Noise Level Contribution at Receptor		Background Noise Level at Receptor L_{A90} [dB(A)]		BS4142 derived Impact Magnitude	100Hz [dB(Z)] Condition Compliance (Yes/No)
		Broadband [dB(A)]	100Hz [dB(Z)]	Daytime	Night Time		
SSR1	GF (Ground Floor)	13.5	25.2	37.7	33.8	No Impact	Yes
	FF (First Floor)	14.1	25.0	37.7	33.8	No Impact	Yes
SSR2	GF	19.6	31.1	32.2	28.4	No Impact	Yes
	FF	21.0	31.5	32.2	28.4	No Impact	Yes
SSR3	GF	13.0	25.4	32.2	28.4	No Impact	Yes
	FF	14.0	25.7	32.2	28.4	No Impact	Yes
SSR4	GF	17.7	30.8	31.0	22.9	No Impact	Yes
	FF	18.3	31.0	31.0	22.9	No Impact	Yes
SSR5	GF	14.1	26.5	50.5	29.9	No Impact	Yes
	FF	15.7	27.0	50.5	29.9	No Impact	Yes
SSR6	GF	10.6	24.0	36.0	28.6	No Impact	Yes
	FF	11.0	24.1	36.0	28.6	No Impact	Yes
SSR7	GF	18.3	31.1	46.3	39.4	No Impact	Yes
	FF	18.8	31.3	46.3	39.4	No Impact	Yes
SSR8	GF	14.4	27.5	58.4	36.8	No Impact	Yes
	FF	15.0	27.7	58.4	36.8	No Impact	Yes

SSR9	GF	11.6	25.1	36.5	32.2	No Impact	Yes
	FF	12.3	25.4	36.5	32.2	No Impact	Yes
SSR10	GF	18.9	29.9	34.0	21.8	No Impact	Yes
	FF	19.5	30.0	34.0	21.8	No Impact	Yes
SSR11	GF	15.4	27.1	56.5	31.3	No Impact	Yes
	FF	16.8	27.7	56.5	31.3	No Impact	Yes
		BS 4142 Criteria Met or 32 dBZ 100 Hz Requirement Met					

25.8.7 Potential Impacts during Decommissioning

309. This section describes the potential impacts of the decommissioning of the onshore infrastructure with regards to impacts on noise and vibration. Further details with regards to decommissioning are provided in Chapter 5 Project Description.

310. No decision has been made regarding the final decommissioning policy for the onshore cables, as it is recognised that industry best practice, rules and legislation change over time. It is likely the cables would be pulled through the ducts and removed, with the ducts themselves left in situ.

311. In relation to the onshore project substation, the programme for decommissioning is expected to be similar in duration to the construction phase. The detailed activities and methodology would be determined later within the project lifetime, but are expected to include:

- Dismantling and removal of outside electrical equipment from outside of the onshore project substation buildings;
- Removal of cabling from site;
- Dismantling and removal of electrical equipment from within the onshore project substation buildings;
- Removal of main onshore project substation buildings and minor services equipment;
- Demolition of the support buildings and removal of fencing;
- Landscaping and reinstatement of the site (including land drainage); and
- Removal of areas of hard standing.

312. Whilst details regarding the decommissioning of the onshore project substation is currently unknown, considering the worst case which would be the removal and reinstatement of the current land use at the site, it is anticipated that the impacts would be no worse than those during construction.

313. The decommissioning methodology would need to be finalised nearer to the end of the lifetime of the project to be in line with current guidance, policy and legislation at that point. Any such methodology would be agreed with the relevant authorities and statutory consultees. The decommissioning works could be subject to a separate licencing and consenting approach.

25.9 Cumulative Impacts

314. The assessment of cumulative impacts has been undertaken here as a two-stage process. Firstly, all the impacts from previous sections have been assessed for potential to act cumulatively with other projects. This summary assessment is set out in Table 25.45.

Table 25.45 Potential cumulative impacts

Impact	Potential for cumulative impact	Rationale
Construction		
Other proposed and consented developments and their associated road traffic.	Yes	There is potential for impacts associated with noise and vibration generated during the construction phase site works to lead to a cumulative impact with other proposed developments (already consented and those in the planning system) where the construction phases of other schemes overlap with Norfolk Boreas and where activities will occur in proximity to the same receptors. There is a potential for a cumulative impact associated with construction phase road traffic to occur during the project construction in conjunction with other proposed schemes. Further details are contained within Chapter 24 Traffic and Transport.
Operation		
Other onshore electrical infrastructure within the vicinity of the onshore project substation	Yes	There is a potential for a cumulative impact associated with operational phase to occur during operation of the onshore project substation in conjunction with other operational noise sources within the vicinity of the onshore project substation. Implementation of appropriate mitigation within the detail design should ensure that any impacts will be of negligible significance.
Decommissioning		
The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and agreed with the regulator. A decommissioning plan will be provided. As such, cumulative impacts during the decommissioning stage are assumed to be no worse than those identified during the construction stage.		

315. The second stage of the CIA is an assessment of whether there is spatial or temporal overlap between the extent of potential effects of the onshore project area and the potential effects of other projects scoped into the CIA upon the same receptors. To identify whether this may occur, the potential nature and extent of effects arising

from all projects scoped into the CIA have been identified and any overlaps between these and the effects identified in section 25.8 have also been identified. Where there is an overlap, an assessment of the cumulative magnitude of effect is provided.

316. Projects identified for potential cumulative impacts were agreed as part of the Norfolk Boreas PEIR (Norfolk Boreas Limited, 2018). These projects, as well as any relevant development applications submitted since this consultation have been considered and their anticipated potential for cumulative impact are detailed in Table 25.46.

Table 25.46 Summary of projects considered for the CIA in relation to noise and vibration

Project	Status	Development period	[2]Distance from Norfolk Boreas (km)	Project definition	Project data status	Included in CIA	Rationale
National Infrastructure Planning							
Norfolk Vanguard Offshore Wind Farm	Application submitted	Expected construction 2020 to 2025	0 – projects are co-located	Full ES available: https://infrastructure.planninginspectorate.gov.uk/projects/eastern/norfolk-vanguard/?ipcsection=docs	High	Yes (Scenario 1 only)	Overlapping proposed project boundaries may result in impacts of a direct and / or indirect nature during construction and operation. However, due to the strategic nature of developing the projects together, cumulative impacts are minimised.
Hornsea Project Three Offshore Wind Farm	Application submitted	Expected construction start date 2021. Duration 6 to 10 years dependent on phasing.	0 – cable intersects project 32km between substation locations	Full ES available: https://infrastructure.planninginspectorate.gov.uk/projects/eastern/hornsea-project-three-offshore-wind-farm/?ipcsection=docs	High	Yes	Overlapping proposed project boundaries may result in impacts of a direct and / or indirect nature during construction where geographical footprints overlap and due to noise

[2] Shortest distance between the considered project and Norfolk Boreas – unless specified otherwise.

Project	Status	Development period	[2]Distance from Norfolk Boreas (km)	Project definition	Project data status	Included in CIA	Rationale
							emissions from construction traffic
Dudgeon Offshore Wind Farm	Commissioned	Constructed	0	http://dudgeonoffshorewind.co.uk/	High	Yes	Overlapping proposed project boundaries may result in impacts of a direct and / or indirect nature during operation.
A47 corridor improvement programme – North Tuddenham to Easton	Pre-application (application due 2020)	Start works April 2021 Open May 2023	26.7	https://highwaysengland.co.uk/projects/a47-north-tuddenham-to-easton-improvement-scheme/	Medium	No	It is likely that these developments will implement site-specific measures to mitigate noise associated with construction works which would be implemented as part of a CoCP for the Highways England programme. It is therefore not anticipated that any cumulative effects associated with the construction phase will be significant.
A47 corridor improvement programme – A47 Blofield to North Burlingham	Pre-application (application due 2019)	Start works 2021 Open 2022	25	https://highwaysengland.co.uk/projects/a47-blofield-to-north-burlingham/	Medium	No	
A47 corridor improvement programme – A47 / A11 Thickthorn	Pre-application (application due 2019)	Start works 2020 Open 2023	18	https://highwaysengland.co.uk/projects/a47-thickthorn-junction/	Medium	No	

Project	Status	Development period	[2]Distance from Norfolk Boreas (km)	Project definition	Project data status	Included in CIA	Rationale
Norwich Western Link	Pre-application	Expected construction start late 2022	2.8	https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/norwich/norwich-western-link	Medium	No	Potential cumulative impacts could occur related to potentially overlapping construction traffic and its associated noise and vibration implications. Noting the lack of information available at this stage, it is not possible to provide a meaningful assessment of cumulative impacts. It is therefore proposed that, if approved, through the development of the TMP, Norfolk Boreas Limited and its Contractors would engage stakeholders to try and establish opportunities to co-ordinate activities and avoid peak traffic impacts.

Project	Status	Development period	[2]Distance from Norfolk Boreas (km)	Project definition	Project data status	Included in CIA	Rationale
Third River Crossing (Great Yarmouth)	Pre-application (application due 2019)	Expected construction start in late 2020 Open early 2023	28	https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/great-yarmouth/third-river-crossing	Medium	Third River Crossing (Great Yarmouth)	Given the large separation distances between the projects it is considered that significant cumulative impacts are not likely to arise.
King's Lynn B Power Station amendments	Approved	Expected construction 2018 to 2022	28	https://www.kingslynnbccgt.co.uk/	High	No	Given the large separation distances between the projects it is considered that significant cumulative impacts are not likely to arise.
North Norfolk District Council							
PF/17/1951 Erection of 43 dwellings and new access with associated landscaping, highways and external works	Approved	Anticipated Q2 2018	0.7	Application available: https://idoxpa.north-norfolk.gov.uk/online-applications/applicationDetails.do?activeTab=summary&keyVal=_NNORF_DCAPR_92323	High	No	It is likely that this development will implement site-specific measures to mitigate noise associated with construction works which would be implemented as part of a CoCP for the housing development. It is therefore not

Project	Status	Development period	[2]Distance from Norfolk Boreas (km)	Project definition	Project data status	Included in CIA	Rationale
							anticipated that any cumulative effects associated with the construction phase will be significant.
Bacton and Walcott Coastal Management Scheme	Approved	Expected construction start date Spring 2019	1.0	Public information leaflets available: https://www.north-norfolk.gov.uk/media/3371/bacton-to-walcott-public-information-booklet-july-2017.pdf	Medium	No	It is likely that this development will implement site-specific measures to mitigate noise associated with construction works which would be implemented as part of their own project CoCP. It is therefore not anticipated that any cumulative effects associated with the construction phase will be significant.
Coastal defence/protection works, Happisburgh PF/18/0751	Approved	Coastal protection over 10 year duration from August 2018	0.12	https://idoxpa.north-norfolk.gov.uk/online-applications/applicationDetails.do?activeTab=summary&keyV	Medium	No	It is likely that this development will implement site-specific measures to mitigate noise associated with construction works. It is therefore not

Project	Status	Development period	[2]Distance from Norfolk Boreas (km)	Project definition	Project data status	Included in CIA	Rationale
				al=_NNORF_DCAPR_93543			anticipated that any cumulative effects associated with the construction phase will be significant.
Breckland Council							
Erection of 85 Dwellings with Associated Open Space 3PL/2018/1246/F	Awaiting Decision	Application received 04/10/18.	1.26	http://planning.breckland.gov.uk/OcellaWeb/planningDetails?reference=3PL/2018/1246/F&from=planningSearch	Medium	No	Given the large separation distances between the projects it is considered that significant cumulative impacts are not likely to arise. It is likely that this development will implement site-specific measures to mitigate noise associated with construction works which would be implemented as part of their own project CoCP. It is therefore not anticipated that any cumulative effects associated with the construction

Project	Status	Development period	[2]Distance from Norfolk Boreas (km)	Project definition	Project data status	Included in CIA	Rationale
							phase will be significant.
Residential development of 40 No. units comprising a mix of housing types, accommodating open space and appropriate associated infrastructure with vehicle access via Hall Road 3PL/2018/0993/F	Approved	Application approved 11/02/19. Construction must begin within 2 years.	1.42	http://planning.breckland.gov.uk/OcellaWeb/planningDetails?reference=3PL/2018/0993/F&from=planningSearch	Medium	No	Given the large separation distances between the projects it is considered that significant cumulative impacts are not likely to arise. It is likely that this development will implement site-specific measures to mitigate noise associated with construction works which would be implemented as part of their own project CoCP. It is therefore not anticipated that any cumulative effects associated with the construction phase will be significant.

317. In summary, the following projects will be assessed for potential direct cumulative impacts:

Scenario 1

- Norfolk Vanguard Offshore Wind Farm;
- Hornsea Project Three Offshore Wind Farm; and
- Dudgeon Offshore Wind Farm.

Scenario 2

- Hornsea Project Three Offshore Wind Farm; and
- Dudgeon Offshore Wind Farm.

25.9.1 Cumulative Impacts during Construction

25.9.1.1 Scenario 1

25.9.1.1.1 Norfolk Boreas and Norfolk Vanguard

318. The impacts of road traffic noise at noise sensitive receptors are predicted to have a **minor adverse** impact for Norfolk Boreas and at worst **moderate adverse** (on three links during 2022) for Norfolk Vanguard. It is anticipated that through the implementation of a TMP for Norfolk Boreas and Norfolk Vanguard, resultant noise contributions will be reduced to at worst a **minor adverse** impact**.** Therefore, with the inclusion of the mitigation measures a **minor adverse** impact is predicted for Norfolk Boreas and Norfolk Vanguard.

319. Cumulative construction noise impacts with Norfolk Vanguard have the potential to occur at landfall receptors and at the onshore project substation and National Grid substation extension receptors. Under Scenario 1 the cable pulling for Norfolk Boreas will be subsequent to the duct installation and cable pulling for Norfolk Vanguard, as such there are no potential cumulative impacts for receptors adjacent to the onshore cable route.

320. Under Scenario 1 there are two potential options for duct installation at the landfall (see section 25.4.1.1 for details). Under Option A (where Norfolk Boreas install ducts in 2024 and 2025) there is potential for cumulative construction impacts from the duct installation for Norfolk Boreas and the cable pulling for Norfolk Vanguard.

321. Under Option B the landfall duct installation is undertaken concurrently for both projects in 2022 and 2023, the potential impacts associated with these works are considered as part of the assessment for Norfolk Boreas (see paragraph 227) and therefore are not repeated here. Under Option B cable pulling for Norfolk Boreas will be after the cable pulling for Norfolk Vanguard, therefore there are no potential cumulative impacts from this activity.

322. Effects at sensitive receptor locations around the landfall have therefore been assessed regarding Option A; duct installation for Norfolk Boreas at the same time as cable pulling for Norfolk Vanguard.

323. There is the potential for cumulative impacts as a result of the construction of Norfolk Boreas onshore project substation and National Grid substation extension and ongoing Norfolk Vanguard onshore project substation and associated National Grid substation works. Effects at sensitive receptor locations around the onshore project substation area have been assessed regarding the following cumulative construction works:

- Onshore project substations for both projects;
- 400kV onshore cable route; and
- Construction of the National Grid substation extension for both projects.

324. The results of the cumulative daytime weekday (07:00 to 19:00 hours) and Saturday (07:00 to 13:00 hours) noise propagation calculations are presented in Appendix 25.2. The noise levels are based on the assumptions and approach detailed in the methodology section of this chapter.

325. Calculated construction noise levels have been determined at the receiver floor level (GF – Ground Floor) and compared with the derived BS 5228 construction threshold noise limit for each receptor which has been derived from the measured baseline noise data contained within Appendix 25.1.

326. Table 25.47 details a summary of the potential construction noise impacts at the agreed receptors (including a conservative 5 dB(A) allowance for the incorporation of standard mitigation measures). It contains details of locations at which an impact has been predicted within each phase or, for phases which have no predicted impacts, the highest predicted construction noise level during the phase.

327. Impact magnitudes have been assessed in accordance with the criteria detailed within Table 25.25 and the significance criteria detailed in Table 25.29.

328. At the landfall during the Norfolk Boreas duct installation and Norfolk Vanguard cable pulling works the impact magnitude was assessed as no impact at all landfall medium sensitivity receptors, this represents a **negligible** impact.

329. At the onshore project substation during the primary works for Norfolk Boreas and electrical plant installation and commissioning for Norfolk Vanguard the impact magnitude was assessed as no impact at all landfall medium sensitivity receptors, this represents a **negligible** impact.

330. During the pre-construction works for Norfolk Boreas and the primary works for Norfolk Vanguard the impact magnitude was assessed as no impact at all receptors, representing a **negligible** impact significance.

Table 25.47 Worst case cumulative construction noise impacts (Norfolk Boreas and Norfolk Vanguard) Scenario 1 daytime

Phase	BS5228 Threshold dB(A)	Predicted noise level $L_{Aeq, 12hr}$ dB (Standard mitigation applied)	Impact Significance (Standard mitigation only)	Required Enhanced Mitigation (Yes/No) and range dB(A)	Residual Impact Significance
Landfall receptors					
Duct Installation Works Option A – 2 drills in landfall compound (Norfolk Boreas Only) Concurrent cable pulling, jointing and commissioning for Norfolk Vanguard	**65**	**42.2 to 50.1**	Negligible	No	Negligible with standard mitigation
Duct Installation Works Option B – 2 drills in landfall compounds (Norfolk Boreas and Norfolk Vanguard) Concurrent Duct installation for Norfolk Vanguard	**65**	**44.3 to 47.7**	Negligible	No	Negligible with standard mitigation
Onshore project substation and National Grid extension receptors					
Pre-construction works Norfolk Boreas and primary works Norfolk Vanguard	**65**	**41.3 to 62.2**	Negligible	No	Negligible with standard mitigation
Primary works for Norfolk Boreas and electrical plant installation and commissioning for Norfolk Vanguard	**65**	**37.3 to 60.6**	Negligible	No	Negligible with standard mitigation
Concurrent cable pulling, jointing and commissioning Norfolk Boreas and Norfolk Vanguard	**65**	**38.8 to 60.7**	Negligible	No	Negligible with standard mitigation
Required Mitigation Key					
No additional mitigation required beyond standard CoCP measures to avoid significant adverse impacts.					

25.9.1.1.2 Norfolk Boreas and Hornsea Project Three

331. There is the potential for construction traffic and phasing to result in noise and vibration cumulative impacts where the same receptors are affected, at the point where the project boundaries for the onshore cable routes overlap (or where the same links are used).

332. The cumulative impacts due to Norfolk Boreas overlapping with the Hornsea Project Three are most likely at the closest receptors where the cable routes cross i.e. CRR15 and CRR16.

333. Where construction works associated with two different schemes are undertaken simultaneously and in close proximity to the same NSR, in theory the noise level experienced at the receptor could increase cumulatively by up to 3dBA (based on the schemes using similar plant, equipment on-time, same separation distance, and all other parameters being equal). If this were the case, the predicted noise levels at CRR15 and CRR16 would remain below the impact threshold; therefore, a **negligible impact** significance.

334. On this basis the cumulative effects due to concurrent Norfolk Boreas construction works and Hornsea Project Three would be of no greater impact than for Norfolk Boreas in isolation.

335. Where the construction of two schemes is non-simultaneous, the temporal extent of potential impacts at a given sensitive receptor could potentially be increased (subject to activity being undertaken).

336. As Hornsea Project Three is subject to EIA, a construction noise and vibration assessment has been undertaken to specify best-practice mitigation to reduce the impacts at nearby receptors. Mitigation measures are specified in the Hornsea Project Three ES (Ørsted, 2018) to reduce the construction noise and vibration impacts of Hornsea Project Three.

337. It is therefore considered that with each scheme adopting best practice measures and a CoCP, cumulative impacts of construction noise and vibration are predicted to have no additional impact.

25.9.1.2 Scenario 2

25.9.1.2.1 Norfolk Boreas and Hornsea Project Three

338. Under Scenario 2 cumulative impacts would only exist with the Hornsea Project Three Project, as Norfolk Vanguard does not proceed to construction. As detailed in the assessment for Scenario 1, the Hornsea Project Three is subject to a construction noise and vibration assessment which outlines best-practice mitigation to reduce the impacts at nearby receptors. It is therefore considered that, with the adoption of best practice, cumulative impacts of construction noise and vibration are predicted to have no additional impact.

25.9.2 Cumulative Impacts during Operation

25.9.2.1 Scenario 1

339. Under Scenario 1 there is potential for a cumulative impact associated with the operational phase of the Norfolk Boreas onshore project substation in conjunction with Norfolk Vanguard and Dudgeon substations.

340. The operational assessment for Norfolk Boreas Scenario 1 (presented in section 25.8.6.1.2) assumes that both the Norfolk Vanguard and Dudgeon substations are operational. As such the assessment presented in section 25.8.6.1.2 includes potential cumulative impacts with Norfolk Vanguard and Dudgeon substations and as such is not repeated here.

341. The operational assessment demonstrates that noise emissions from the cumulative onshore substations, specifically, operational noise from Norfolk Boreas, Norfolk Vanguard and Dudgeon substation does not exceed the operational noise levels specified by Breckland Council (see paragraph 109).

25.9.2.2 Scenario 2

342. Under Scenario 2 there is potential for a cumulative impact associated with the operational phase of the Norfolk Boreas onshore project substation in conjunction with Dudgeon substation.

343. The operational assessment for Norfolk Boreas Scenario 2 (presented in section 25.8.6.1.1) assumes that Dudgeon substation is operational. As such the assessment presented in section 25.8.6.1.1 includes potential cumulative impacts with Dudgeon substation and as such is not repeated here.

344. The operational assessment demonstrates that noise emissions from the cumulative onshore substations, specifically, operational noise from Norfolk Boreas and Dudgeon substation does not exceed the noise levels specified by Breckland Council (see paragraph 109).

25.9.3 Cumulative Impacts during Decommissioning

345. Decommissioning of Norfolk Vanguard and Hornsea Project Three may potentially take place at the same time as Norfolk Boreas. The detail and scope of the decommissioning works for Norfolk Boreas will be determined by the relevant legislation and guidance at the time of decommissioning and agreed with the regulator. A decommissioning plan will be provided. As such, cumulative impacts during the decommissioning stage are assumed to be no worse than those identified during the construction stage.

25.10 Inter-relationships

346. Parameters or 'sources' that are considered to interact with receptors identified in this chapter are listed in Table 25.48.

Table 25.48 Noise and vibration inter-relationships

Topic and description	Related Chapter	Where addressed in this chapter	Rationale
Construction related traffic noise impacts	Chapter 22 Onshore Ecology Chapter 23 Onshore Ornithology Chapter 24 Traffic and Transport Chapter 27 Human Health Chapter 28 Onshore Archaeology and Cultural Heritage Chapter 30 Tourism and Recreation	Section 25.8.5.2	There could be potential noise impacts related to the construction phase traffic.
Operational noise impacts	Chapter 22 Onshore Ecology Chapter 23 Onshore Ornithology Chapter 24 Traffic and Transport Chapter 27 Human Health Chapter 28 Onshore Archaeology and Cultural Heritage Chapter 30 Tourism and Recreation	Section 25.9.2	There could be potential impacts as a result of operational noise emissions from the onshore project substation.

25.11 Interactions

347. The impacts identified and assessed in this chapter have the potential to interact with each other, which could give rise to synergistic impacts as a result of that interaction. The worst case impacts assessed within the chapter take these interactions into account and for the impact assessments are considered conservative and robust. For clarity the areas of interaction between impacts are presented in Table 25.49, along with an indication as to whether the interaction may give rise to synergistic impacts.

Table 25.49 Interaction between impacts

Potential interaction between impacts		
Construction		
	1 Construction Traffic using Highways	**2 Construction related activities/plant**
1 Construction traffic using Highways	-	Yes
2 Construction related activities and plant	Yes	-
Operation		
	1 Operational noise at Ecological receptors	**2 Operational noise at Human receptors**
1 Operational noise at Ecological receptors	-	No
2 Operational noise at Human receptors	No	-
Decommissioning		
It is anticipated that the decommissioning impacts will be no worse than those of construction.		

25.12 Summary

348. A summary of the potential impacts identified in relation to noise and vibration is provided in Table 25.50 and Table 25.51 for Scenario 1 and Scenario 2 respectively.

349. In summary, the main findings from the impact assessment based on the worst case assumptions in Scenario 2 outline that for the assessed construction phases, impact significance at medium sensitivity receptors are predicted to range from **negligible** to **major adverse**. However, with the adoption of best practices measures set out in a CoCP (DCO Requirement 20), enhanced mitigation measures and BPM, residual impacts are predicted to reduce to **negligible**.

350. The main findings from the impact assessment based on the worst case assumptions in Scenario 1 outline that for the assessed construction phases, impact significance at medium sensitivity receptors are predicted to range from **negligible** to **major adverse**. However, with the adoption of best practices measures set out in a CoCP (DCO Requirement 20), enhanced mitigation measures and BPM, residual impacts are predicted to reduce to **negligible**.

351. Operational phase impacts for both scenarios were predicted to be **moderate adverse** at assessed sensitive receptors without mitigation. With the incorporation of suitable mitigation (as detailed in Table 25.42), residual impacts are predicted to reduce to **negligible** at identified receptors.

Table 25.50 Potential impacts identified for noise and vibration under Scenario 1

Potential Impact	Receptor	Value/ Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Construction						
Landfall Daytime	Residential	Medium	No Impact	**Negligible**	CNMP	**Negligible**
Landfall Evening and weekends	Residential	Medium	No Impact	**Negligible**	CNMP	**Negligible**
Landfall night-time	Residential	Medium	No Impact to Minor Adverse	**Negligible to Minor Adverse**	CNMP + Enhanced mitigation (localised screening and increased separation distances).	**Negligible**
Onshore cable route Daytime	Residential	Medium	No Impact to Major Adverse	**No Impact to Major Adverse**	CNMP + Enhanced mitigation (localised screening and increased separation distances).	**Negligible**
Onshore project substation and National Grid substation extension receptors Daytime (in-combination)	Residential	Medium	No Impact	**Negligible**	CNMP	**Negligible**
Traffic	Residential	Medium	No Change to Minor	**Negligible to Minor Adverse**	TMP (refer to Chapter 24 Traffic and Transport)	**Minor Adverse**
Vibration	Residential	Medium	No impact	**Negligible**	None required.	**Negligible**
Operation						
Operational noise	Residential	Medium	No Impact to Moderate Adverse	**Negligible to Moderate Adverse**	Designed to prevent significant adverse	**Negligible**

Potential Impact	Receptor	Value/ Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
					impacts, BAT. (see section 25.8.6.2).	
Decommissioning						
Whilst details regarding the decommissioning is currently unknown, considering the worst case it is anticipated that the impacts would be no worse than those during construction.						
Cumulative - Construction						
Construction noise	Residential	Medium	No Impact	**Negligible Adverse**	CNMP	**Negligible**
Cumulative - Operation						
Operational noise	Residential	Medium	No Impact to Moderate Adverse	**Negligible to Moderate Adverse**	Designed to prevent significant adverse impacts, BAT. (see section 25.8.6.2).	**Negligible**
Cumulative - Decommissioning						
The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and agreed with the regulator. A decommissioning plan will be provided. As such, cumulative impacts during the decommissioning stage are assumed to be no worse than those identified during the construction stage.						

Table 25.51 Potential impacts identified for noise and vibration under Scenario 2

Potential Impact	Receptor	Value/ Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Construction (including pre-construction)						
Landfall Daytime	Residential	Medium	No Impact	**Negligible**	CNMP	**Negligible**
Landfall Evening and weekends	Residential	Medium	No Impact	**Negligible**	CNMP	**Negligible**
Landfall Night-time	Residential	Medium	Negligible	**Negligible**	CNMP	**Negligible**
Onshore cable route Daytime	Residential	Medium	No Impact to Major Adverse	**Negligible to Major Adverse**	CNMP + Enhanced mitigation (localised screening and increased separation distances).	**Negligible**
Onshore cable route Evening and weekends	Residential	Medium	No Impact	**Negligible**	CNMP	**Negligible**
Onshore cable route Night time	Residential	Medium	No Impact to Major Adverse	**Negligible to Major Adverse**	CNMP + Enhanced mitigation (localised screening and increased separation distances).	**Negligible**
Onshore project substation and National Grid substation extension receptors Daytime	Residential	Medium	No Impact	**Negligible**	CNMP	**Negligible**
Traffic	Residential	Medium	No Change to Moderate	**Negligible to Moderate Adverse Impact**	TMP (refer to Chapter 24 Traffic and Transport)	**Minor Adverse**
Vibration	Residential	Medium	No impact	**Negligible**	None required.	**Negligible**

Potential Impact	Receptor	Value/ Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Operation						
Operational noise	Residential	Medium	No Impact to Moderate Adverse	**Negligible to Moderate Adverse**	Designed to prevent significant adverse impacts, BAT (see section 25.8.6.2).	**Negligible**
Decommissioning						
Whilst details regarding the decommissioning is currently unknown, considering the worst case it is anticipated that the impacts would be no worse than those during construction.						
Cumulative - Construction						
Construction noise	Residential	Medium	No Impact	**Negligible**	CNMP	**Negligible**
Cumulative - Operation						
Operation noise	Residential	Medium	No Impact to Moderate Adverse	**Negligible to Moderate Adverse**	Designed to prevent significant adverse impacts, BAT (see section 25.8.6.2).	**Negligible**
Cumulative - Decommissioning						
The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and agreed with the regulator. A decommissioning plan will be provided. As such, cumulative impacts during the decommissioning stage are assumed to be no worse than those identified during the construction stage.						

25.13 References

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