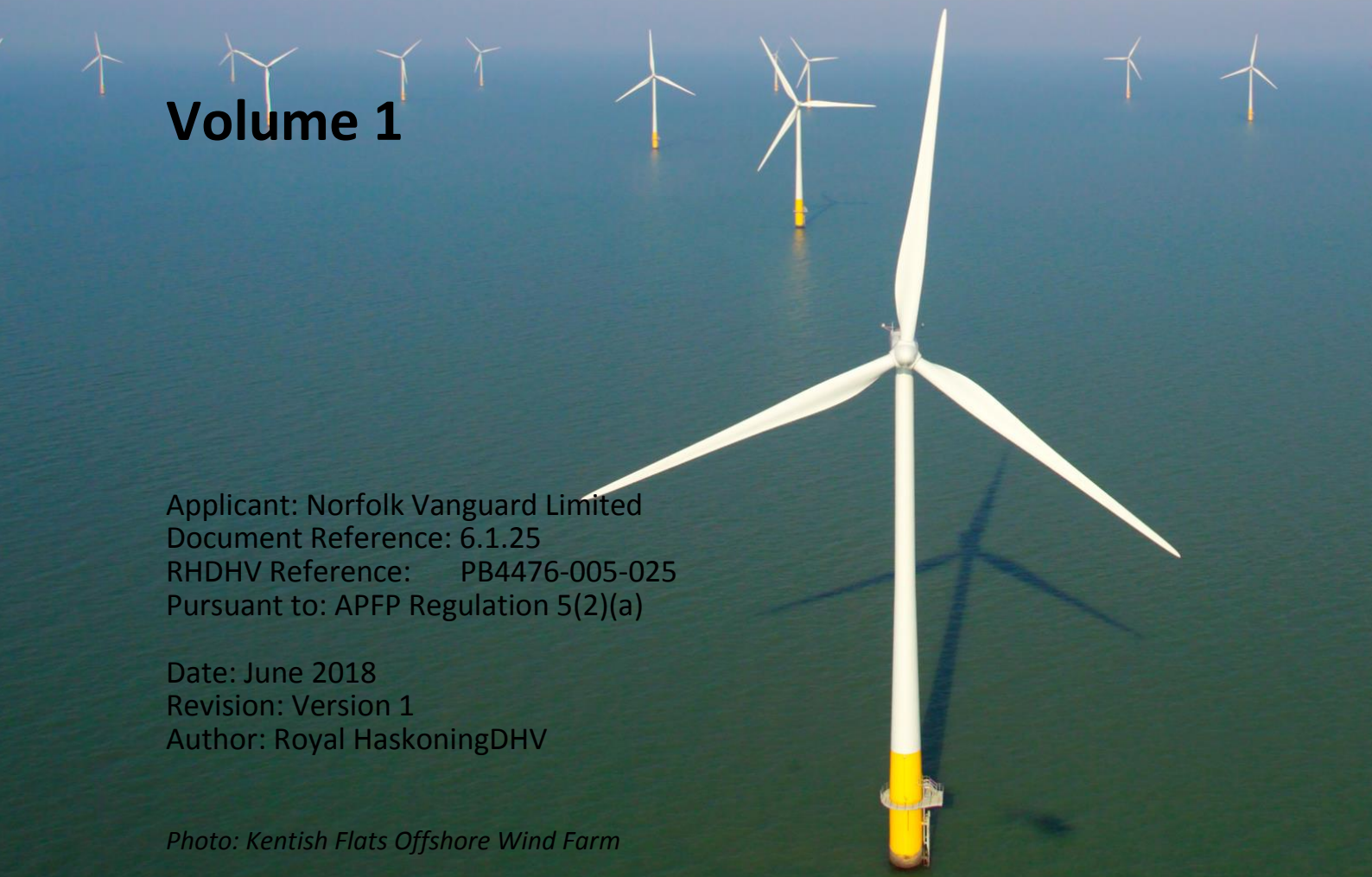
# Norfolk Vanguard Offshore Wind Farm

# Chapter 25

## Onshore Noise and Vibration

## Environmental Statement

## Volume 1



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# Environmental Impact Assessment
# Environmental Statement

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For and on behalf of Norfolk Vanguard Limited

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## Glossary

| | |
|---|---|
| AAWT | Annual Average Weekday Traffic |
| BAT | Best Available Technology |
| BPM | Best Practicable Means |
| BS | British Standard |
| CNMP | Construction Noise Management Plan |
| CoCP | Code of Construction Practice |
| CRTN | Calculation of Road Traffic Noise |
| CRS | Cable Relay Station |
| CWS | County Wildlife Site |
| DMRB | Design Manual for Roads and Bridges |
| EPA | Environmental Protection Act |
| ETG | Expert Topic Group |
| eVDV | Estimated Vibration Dose Value |
| HVAC | High Voltage Alternating Current |
| HVDC | High Voltage Direct Current |
| 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 |
| NPSE | Noise Policy Statement for England |
| NSAG | Necton Substation Action Group |
| OAE | Observed Adverse Effect |
| OCoCP | Outline Code of Construction Practice |
| OLEMS | Outline Landscape and Environmental Management Strategy |
| PDS | Project Design Statement |
| PPG | Planning Practice Guidance |
| PPV | Peak Particle Velocity |
| SGT | Super Grid transformer |
| SLM | Sound Level Meter |
| SOAEL | Significant Observed Adverse Effect Level |
| SoS | Secretary of State |
| STATCOM | Static Synchronous Compensator |
| 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 |
| WHO | World Health Organisation |

# Terminology

| | |
|---|---|
| C | The spectrum adaptation terms C and $C_{tr}$ are used to take into account different source spectra as indicated in the standard.<br><br>C : A-weighted Pink Noise spectrum.<br>$C_{tr}$ : A-weighted urban traffic noise spectrum.<br><br>C and $C_{tr}$ corrections can also be added to $R_w$ (see below) |
| $C_{tr}$ | |
| Cable Relay Station | Primarily comprised of an outdoor compound containing reactors (also called inductors, or coils) and switchgear to increase the power transfer capability of the cables under the HVAC technology scenario as considered in the PEIR. This is no longer required for the project as the HVDC technology has been selected. |
| 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. |
| $L_{A10,T}$ | 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. |
| 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 substation extension | The permanent footprint of the National Grid substation extension |
| Necton National Grid substation | The existing 400kV substation at Necton, which will be the grid connection location for Norfolk Vanguard |

| | |
|---|---|
| Onshore cable corridor | 200m wide onshore corridor within which the onshore cable route would be located as submitted for PEIR. |
| Onshore cable route | The 45m easement 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 the electricity 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 | All onshore electrical infrastructure (landfall; onshore cable route, accesses, trenchless crossing technique (e.g. Horizontal Directional Drilling (HDD)) zones and mobilisation areas; onshore project substation and extension to the Necton National Grid substation and overhead line modification) |
| 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 Vanguard Limited. |
| The OWF sites | The two distinct offshore wind farm areas, Norfolk Vanguard East and Norfolk Vanguard West. |
| The project | Norfolk Vanguard Offshore 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 within the landfall |
| Trenchless crossing zone (e.g. HDD) | Temporary areas required for trenchless crossing works. |
| Workfront | The 150m length of onshore cable route within which duct installation would occur |

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# 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 Vanguard 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 and Appendix 25.3 Operational Phase Assessment. Figures which accompany this chapter are provided in Volume 2 Figures.

4. 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

5. 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

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

7. 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."*

8. Section 80 of the EPA 1990 provides local planning 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

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

10. 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 planning 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.

### 25.2.2 Planning Policy

11. There are a number of pieces of planning policy applicable to noise and vibration. The following key pieces of policy are relevant to this chapter.

#### 25.2.2.1 National Planning Policy

##### *25.2.2.1.1 National Policy Statements (NPS)*

12. 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) (DECC, 2011a);
- NPS for Renewable Energy Infrastructure (EN-3) (DECC, 2011b); and
- NPS for Electricity Networks Infrastructure (EN-5) (DECC, 2011c).

13. 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 Reference |
|---|---|---|
| Where noise impacts are likely to arise, the applicant should include:<br>• 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;<br>• Identification of noise sensitive premises and noise sensitive areas that may be affected;<br>• The characteristics of the existing noise environment;<br>• A prediction of how the noise environment will change with the proposed development;<br>• In the shorter term such as during the construction period;<br>• In the longer term during the operating life of the infrastructure;<br>• At particular times of the day, evening and night as appropriate;<br>• An assessment of the effect of predicted changes in the noise environment on any noise sensitive premises and noise sensitive areas; and<br>• Measures to be employed in mitigating noise.<br>• 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 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 relates to the offshore environment. Those potential noise impacts are considered separately within Chapter 11 Fish and Shellfish and Chapter 12 Marine Mammals. |

| NPS Requirement | NPS Reference | ES Reference |
|---|---|---|
| | | The current relevant British Standards have been used within this assessment detailed within section 0. |
| 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; however, this does not involve altering the geographical position of the line and further operational assessment of rain-induced noise is not considered necessary.<br><br>BS 4142:1997 was superseded in 2014. Where BS 4142 is referred to in this document the 2014 revision has been applied which is in accordance with current best practice.<br><br>See Chapter 5 Project Description for more information on works related to overhead lines. |

14. 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".*

*25.2.2.1.2 National Planning Policy Framework 2012*

15. The National Planning Policy Framework (NPPF) was introduced in March 2012 replacing the former Planning Policy Guidance 24: Planning and Noise.

16. Paragraph 123 of the National Planning Policy Framework states that planning policies and decisions should aim to:

- *"Avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;*
- *Mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through use of conditions;*
- *Recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established; and*
- *Identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason."*

17. The NPPF also refers to the Noise Policy Statement for England (NPSE) (Defra, 2010).

*25.2.2.1.3 Noise Policy Statement for England, 2010*

18. 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."*

19. 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).

20. 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".*

21. 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.

22. 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).

23. 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".*

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

#### *25.2.2.1.4 National Planning Practice Guidance for Noise (NPPG) 2014*

25. The National Planning Practice Guidance for Noise (NPPG Noise, December 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.

### 25.2.2.2 Local Planning Policy

26. 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;
- North Norfolk District Council.

27. 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 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. |

### 25.2.3 Guidance

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

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

29. 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.

#### 25.2.3.2 BS 5228-1:2007+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1: Noise

30. 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 British Standard provides guidance on methods of predicting and measuring noise and assessing its impact on those exposed to it.

#### 25.2.3.3 BS 5228-1:2007+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 2: Vibration

31. 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.

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

32. 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.

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

33. 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.

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

34. 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.

#### 25.2.3.7 Calculation of Road Traffic Noise (CRTN) 1988

35. The Calculation of Road Traffic Noise (CRTN) document 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, different road surfacing, inclination, screening by barriers and relative height of source and receiver.

#### 25.2.3.8 Design Manual for Roads and Bridges, 2011

36. 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) contains advice and information on transport-related noise and vibration, which has relevance with regard to 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.

#### 25.2.3.9 ISO 3744

37. 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, in order to calculate the sound power level produced by the noise source.

#### 25.2.3.10 ISO 717

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

#### 25.2.3.11 ISO 9613-2

39. 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.

#### 25.2.3.12 WHO (1999) Guidelines for Community Noise

40. 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.

41. 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."*

42. 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."*

#### 25.2.3.13 WHO (2009) Night Noise Guidelines for Europe

43. 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."*

## 25.3 Consultation

44. Consultation is a key driver of the EIA and ES, 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 with Norfolk County Council, Breckland Council, Broadland District Council and North Norfolk District Council through the Scoping Report (Royal HaskoningDHV, 2016), face to face Expert Topic Group (ETG) meetings held in January and July 2017, the Preliminary Environmental Information Report (PEIR) (Norfolk Vanguard Limited, 2017) and further telephone/email communications in January and February 2018. Full details of the project consultation process are presented within Chapter 7 Technical Consultation.

45. A summary of the consultation that has been undertaken to date with respect to noise and vibration is provided in Table 25.3.

**Table 25.3 Consultation responses**

| Consultee | Date /document | Comment | Response / where addressed in the ES |
|---|---|---|---|
| Secretary of State | November 2016 (scoping response, statutory). | The Secretary of State recommends that the methodology and choice of noise receptors are agreed with the relevant Environmental Health Department of the Council and the Environment Agency. | The overall methodology has been agreed as part of the ETG meetings.<br>Follow up consultation meetings held with stakeholders to discuss content on the 25th January and 20th July 2017 where noise receptors used in the baseline survey were agreed as being representative. |
| Secretary of State | November 2016 (scoping response, statutory). | The ES should provide a description of the noise generation aspects of the proposed project 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. |
| Secretary of State | November 2016 (scoping response, statutory). | 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. |

| Consultee | Date /document | Comment | Response / where addressed in the ES |
|---|---|---|---|
| Secretary of State | November 2016 (scoping response, statutory). | 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. | Refer to section 25.4.1.3.<br><br>The selection of HVDC electrical scenario minimises environmental impacts by reducing the cable route width to 45m, avoiding the requirement for a CRS, reducing the overall total footprint of the project and reducing the overall construction programme by up to one year. |
| Secretary of State | November 2016 (scoping response, statutory). | Noise impacts on people should be specifically addressed and particularly any potential noise disturbance at night and other unsocial hours such as weekends and public holidays. | Refer to section 25.8.3 and section 25.8.6. |
| Secretary of State | November 2016 (scoping response, statutory). | Paragraph 1079 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 Secretary of State 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 25.4.1.2. |
| Secretary of State | November 2016 (scoping response, statutory). | Paragraph 1082 of the Scoping Report states that "there are considered to be no 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 Secretary of State does not agree this can be scoped out at this stage. | Norfolk Vanguard Limited has reviewed consultation received. A key decision is to deploy High Voltage Direct Current (HVDC) technology as the export system and this removes the need for a Cable Relay Station from the project.<br><br>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.<br><br>"*Damping of noise radiating surfaces* |

| Consultee | Date /document | Comment | Response / where addressed in the ES |
|---|---|---|---|
| | | | *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).<br><br>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. Additionally, the closest receptor locations to the onshore project substation are circa 750m away. At a setback distance of 750m it is very unlikely that any vibration levels would be perceptible at receptor locations. |
| Secretary of State | November 2016 (scoping response, statutory). | Consideration should be given to the potential noise impacts resulting from the maintenance campaigns referred to in paragraph 192 of the Scoping Report, which are stated 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.<br><br>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. |
| Secretary of State | November 2016 (scoping response, statutory). | The Secretary of State welcomes that the Best Practice Measures will be set out in the CoCP. | An outline Code of Construction Practice (OCoCP) (document reference 8.1) is included with the Development Consent Order (DCO) documentation, and sets out the management measure for any onshore construction works associated with the project. |
| Secretary of State | November 2016 (scoping response, statutory). | 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. These measures should be taken into account in other technical assessments, for example the landscape and visual assessment and the ecological assessment. | Site specific mitigation measures have been proposed and assessed. The detailed design stage will confirm and refine the proposed mitigation strategy. |
| Secretary of State | November 2016 (scoping | Paragraph 1096 of the Scoping Report states that the spatial | Receptor locations considered for construction and operational phases are |

| Consultee | Date /document | Comment | Response / where addressed in the ES |
|---|---|---|---|
| | response, statutory). | 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, and should include for potential recreational users of Public Rights of Way (PRoW). | the closest sensitive receptors to the onshore cable route; therefore, the noise levels likely to be experienced along the PRoW are likely to be similar to those predicted from the noise modelling. However, in addition any associated impacts would be transient as the receptor would be passing through rather than set at a fixed location. Noise sensitive receptors are shown on Figure 25.2 and are detailed in Appendix 25.1. Also refer to Chapter 30 Tourism and Recreation.<br>Section 25.8.2 details those aspects of the project that could potentially affect sensitive receptors. |
| Secretary of State | November 2016 (scoping response, statutory). | Similarly, paragraph 1096 states that traffic routes subject to "significant changes in traffic flows" would be included in the assessment. The ES should explain how a 'significant change' has been determined in accordance with relevant guidance, with cross reference to the traffic and transport chapter where appropriate. | Refer to Construction Road Traffic Emissions Assessment Methodology section 25.4.1.1.3.<br>Also refer to Chapter 24 Traffic and Transport. |
| Secretary of State | November 2016 (scoping response, statutory). | The Secretary of State 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. | Figure 22.2 Statutory designated sites 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.<br>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 significant impacts have been predicted.<br>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.<br>Chapter 23 Onshore Ornithology states |

| Consultee | Date /document | Comment | Response / where addressed in the ES |
|---|---|---|---|
| | | | that notable wintering / on passage bird species have been recorded within the onshore cable route. These species will be subject to potential noise disturbance (in addition to visual and light disturbance) for the duration of the construction phase (expected to be two years (duct installation) plus a further 10 weeks per joint location during the two-year cable pull). Chapter 23 Onshore Ornithology identified an impact of at most moderate adverse significance arising from noise, visual and light disturbance upon these receptors under a worst case scenario. Detailed mitigation in relation to this impact will be provided within the draft Outline Landscape and Environmental Management Strategy (OLEMS) submitted alongside the final ES. No significant impacts upon ornithology receptors were identified within Chapter 23 Onshore Ornithology. |
| Secretary of State | November 2016 (scoping response, statutory). | Consideration should be given to monitoring noise complaints during construction and when the project is operational. | An outline CoCP (document 8.1) is submitted alongside the DCO application, detailing the objectives for managing and minimising construction noise and vibration on-site and at nearby sensitive receptors.<br>Detailed design of onshore assets will incorporate Best Available Technique (BAT) and Best Practicable Means (BPM) to minimise any associated noise impacts. Furthermore, in the unlikely event of an operational noise complaint, investigations will be undertaken post liaison with the relevant local authority. |
| Secretary of State | November 2016 (scoping response, statutory). | Traffic and transport is not specified as a topic for assessment under Schedule 4; although in line with good practice the Secretary of State considers it is an important consideration per se, as well as being the source of further impacts in terms of air quality and noise and vibration. | Refer to sections 25.4.1.1.3 and 25.8.5.5. |
| Highways England | November 2016 (scoping response, | I note the proximity to the A47 and would ask that we be consulted on any further scoping | Refer to Sections 25.4.1.1.3 and 25.8.5.5. |

| Consultee | Date /document | Comment | Response / where addressed in the ES |
|---|---|---|---|
| | statutory). | work for this site if it is going to impact in any way – e.g. congestion due to the movement of equipment, noise or general impact on our network. | |
| Breckland District Council | March 2018. | "I have read the documents provided and am happy with the information provided. It is clear that sufficient mitigation can be provided for the harmonic filter reactors and auto transformers to reduce the overall noise level at the Noise Sensitive Receptors (NSR) to an acceptable level, complying with the suggested conditions and falling within the no impact category of BS4142. I also think it sensible to wait until the detail design stage before committing to a final plan of mitigation." | Refer to the operational noise modelling presented in section 25.8. |
| Norfolk Vanguard Limited has reviewed consultation received and in light of the feedback, has made a decision in relation to the project design to deploy High Voltage Direct Current (HVDC) technology as the export system. This method removes the need for a Cable Relay Station (CRS) from the project. Responses relating to a CRS are therefore not included in the statutory consultation table. | | | |

## 25.4 Assessment Methodology

### 25.4.1 Impact Assessment Methodology

46. This section sets out the overall approach to the impact assessment, as agreed with stakeholders during the ETGs.

#### 25.4.1.1 Construction Phase Noise Assessment

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

48. The approved approach outlined within the issued noise method statement and subsequently used in the PEIR and this assessment is the threshold based 'ABC' method. BS 5228 details the method, 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. | | | |

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

50. 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."*

51. 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.

52. 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.

53. Construction noise impacts were assessed using the impact magnitude presented in Table 25.6 for the daytime period, Table 25.7 for the evening and weekend periods, and Table 25.8 for the night time period.

54. Proposed construction phase programmes are provided in section 5.5.8 in Chapter 5 Project Description and reproduced in Table 25.5 below.

**Table 25.5 Indicative project construction programme**

| Activity | Year | | | | | |
|---|---|---|---|---|---|---|
| | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
| **Landfall** | | | | | | |
| Duct Installation | | | | | | |
| Cable Pull, Joint and Commission | | | | | | |
| ***Phase 1*** | | | | | | |
| ***Phase 2*** | | | | | | |
| **Onshore cable route** | | | | | | |
| **Preconstruction works** | | | | | | |
| **Duct installation works** | | | | | | |
| **Cable pull, joint and commission** | | | | | | |
| ***Phase 1*** | | | | | | |
| ***Phase 2*** | | | | | | |
| **Onshore project substation** | | | | | | |
| **Preconstruction works** | | | | | | |
| **Primary works** | | | | | | |
| **Electrical plant installation and commission** | | | | | | |
| ***Phase 1*** | | | | | | |
| ***Phase 2*** | | | | | | |

**Table 25.6 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 |

| Impact magnitude | Construction noise level (dB) | | |
|---|---|---|---|
| | A 65dB threshold | B 70dB threshold | C 75dB threshold |
| 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 25.7 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 25.8 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 |

#### *25.4.1.1.1 Necton National Grid substation extension*

55. Noise impacts during construction at the National Grid substation extension have been assessed in accordance with BS 5228.

56. In order 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.

57. 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.

*25.4.1.1.2 Assumptions and indicative plant list*

58. Based on Chapter 5 Project Description, an indicative list of construction equipment has been developed for the construction programme detailed in Table 25.9 to Table 25.14.

**Table 25.9 Construction noise – onshore project substation and National Grid substation extension**

| 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 25.10 Construction noise – duct installation (per workfront)**

| 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 25.11 Construction noise – temporary access tracks and pre-construction works**

| 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 25.12 Construction noise – trenchless crossing (per location)

| Name | No. | Source Type | LwA dB(A) | On time Correction |
|---|---|---|---|---|
| Tracked Excavator | 1 | Point | 107 | 50% |
| Backhoe Loader | 1 | Point | 96 | 50% |
| Bulldozer | 1 | Point | 108 | 50% |
| Dumper | 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 | Point | 105 | 75% |
| Water Pump | 1 | Point | 93 | 75% |
| Generator | 1 | Point | 105 | 100% |
| *Modelled as 1 source with 75% on time as equivalent to 3 sources with 25% on time | | | | |

### Table 25.13 Construction noise – temporary works areas

| 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% |
| Mobile Crane* | 1 | Point | 106 | 25% |
| Generator | 1 | Point | 105 | 100% |
| *Pre-construction and demobilisation set up | | | | |

### Table 25.14 Construction noise – cable pulling (per workfront)

| 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% |

| Name | No. | Source Type | LwA dB(A) | On time Correction |
|---|---|---|---|---|
| Generator | 1 | Point | 105 | 100% |

*25.4.1.1.3 Road traffic noise and vibration emissions assessment*

59. 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 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.

60. 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.

61. Construction phase road link dB change was assessed using the impact magnitude criteria in Table 25.15. 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 25.15 Significance 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 |

62. 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"*

63. There are two road network links which have been identified through the assessment as resulting in moderate adverse (Link 21 and 25, see Appendix 25.2) with all others minor, negligible or no impact. These impacts would be temporary in nature. A Traffic Management Plan (TMP) will be developed to ensure that the spatial and temporal impacts associated with the construction phase are minimised (See Chapter 24 Traffic and Transport). An Outline Traffic Management Plan (OTMP) (document reference 8.8) has been prepared and submitted with the DCO application. Therefore, a detailed noise assessment associated with the construction phase road traffic is not required. The road traffic assessment methodology of assessing relative change rather than detailed modelling has been discussed and agreed as part of the ETGs under the Evidence Plan Process through the method statements and subsequent submission and review of the PEIR by stakeholders.

#### 25.4.1.2 Construction Phase Vibration Assessment

64. 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.

65. 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.

66. 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.

67. 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.

68. 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 Research (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.

69. 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.

70. 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.

71. 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.

72. BS 6472 describes how to determine the vibration dose value (VDV) from frequency-weighted vibration measurements. VDV is defined by the following equation:

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

73. 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.

74. 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.

75. 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.

76. 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 25.16 were adopted based on BS 5228. Limits for transient vibration, above which cosmetic damage could occur, are given numerically in terms of PPV.

**Table 25.16 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<br>Industrial and heavy commercial buildings | 50mms$^{-1}$ at 4Hz and above | |
| 2 | Un-reinforced or light framed structures<br>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 |

77. Table 25.17 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 25.17.

**Table 25.17 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 on uneven Haul Route | 277m | 60m | 3m | 2m |

78. Table 25.18 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 25.18 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 |

| Building type (limits on vibrations from Eurocode 3) | Piling Method | | |
|---|---|---|---|
| | Press-in | 25kJ drop hammer | 170 kW 27Hz vibrohammer |
| 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 |

79. For construction vibration from sources other than blasting, the vibration level and effects presented in Table 25.19 were adopted based on Table B-1 of BS 5228-2. These levels and effects are based on human perception of vibration in residential environments.

**Table 25.19 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

80. 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.

81. 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.

82. 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."*

83. 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.

84. 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.

85. 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.

86. 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".*

87. 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."*

88. Norfolk Vanguard onshore electrical infrastructure will be designed to meet the measured existing background noise levels obtained during the 2017 baseline noise survey at each of the receptor locations. Due to the separation distance and existing ambient soundscape no penalty corrections for intermittency, tonality or impulsivity have been included as these acoustic features are added based on perceptibility at the receptor location. As such no penalties have been applied. An indicative layout of the onshore project substation is detailed in Appendix 25.3, Plate 25.1.

89. 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 hrs to 23:00 hrs); and
- 15 minutes during night-time hours (23:00 to 07:00 hrs).

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

91. 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.

92. Noise levels for the operational phase were predicted at the same NSR locations detailed in Table 25.26. The calculation algorithm described in ISO 9613 was used in the operational noise propagation modelling exercise.

93. 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 25.20.

**Table 25.20 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 |

94. During consultation (at ETG meetings) 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 Necton substation:

- The noise rating level (defined as set out in BS4142) 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 32dB $L_{Leq\ (15\ minutes)}$ in the 100Hz third octave band, at any time at a free field location immediately adjacent to any noise sensitive location.

95. These limits as agreed would apply to Norfolk Vanguard.

*25.4.1.3.1 Onshore project substation*

96. Since the publication of the PEIR in October 2017, Norfolk Vanguard Limited has updated the project design based on consultation responses, community feedback and as a result of progressing discussions with technology providers. The PEIR previously included an assessment of the likely worst case for the High Voltage Alternating Current (HVAC) and High Voltage Direct Current (HVDC) transmission options for the project using the available information at that time. The subsequent PEIR Chapter 25 Noise and Vibration assumed the HVAC option as a worst case in terms of noise emissions for the onshore project substation. The cumulative noise impacts associated with Norfolk Boreas (DCO application due to be submitted Q2

2019), the sister project to Norfolk Vanguard, were also included as part of the preliminary assessments. In February 2018, a refined design was announced by Norfolk Vanguard Limited which committed the project to HVDC technology as part of the DCO application. By making this commitment to the HVDC option, the requirement for an onshore CRS has been removed from the project.

97. This assessment therefore represents the updated results of noise modelling based on the revised project design (HVDC) and updated performance specification received from the supply chain technology providers. This chapter sets out the modelling approach applied using HVDC as the worst case scenario along with the assumptions which underpin it. No further consultation was therefore deemed necessary.

98. It is important to note that the existing Necton National Grid substation will be extended to accommodate the onshore project substation connection, and forms part of the Norfolk Vanguard DCO application. Any extension required to the existing Necton National Grid substation to accommodate the Norfolk Boreas project will be subject to a separate DCO application. The equipment required to extend the existing Necton National Grid substation for operation 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 previous ETG meetings. 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.

99. For the onshore project substation, the following scenario was assessed:

- Scenario 1 – Norfolk Vanguard HVDC onshore project substation in isolation.

100. The main HVDC noise sources associated with the onshore project substation have been identified within Table 25.21.

**Table 25.21 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- | 8* | Box | 97.8 | 9.5m | 68 | 75 | 59 | 86 | 88 | 88 | 82 | 81 | 96 |

| Name | No. | Source Type | LwA dB(A) | Relative Height | Frequency (Hz) [dB(A)] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| transformers | | | | | | | | | | | | | |
| 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 | | | | | | | | | | | | | |

101. All sound power levels were calculated using source measurements obtained by Norfolk Vanguard 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.

102. The attenuation afforded by the converter hall construction is detailed in Table 25.22 below.

**Table 25.22 Converter hall construction noise attenuation**

| Name | Lw" dB(A)* | Rw | C | Ctr | Frequency (Hz) [dB(A)] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 125 | 250 | 500 | 1000 | 2000 | 4000 |
| Converter Hall Construction | 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. | | | | | | | | | | |

103. 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 25.23.

**Table 25.23 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 |

104. This chapter also considers cumulative noise impacts from the operational substation for Dudgeon Offshore Wind Farm onshore substation (hereafter referred

to as 'Dudgeon substation') and Norfolk Boreas onshore project substation in combination 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 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 Vanguard onshore project substation and ensure the amenity of nearby residents.

#### 25.4.1.4 Sensitivity

105. 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."*

106. 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 25.24.

**Table 25.24 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 | |
| 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 | Observed Adverse Effect | Mitigate and reduce to a minimum |

| Perception | Examples of outcomes | Increasing effect level | Action |
|---|---|---|---|
| | 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. | | |
| | | 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 |

107. 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 25.25 presents the definitions used relating to the sensitivity of the receptor.

**Table 25.25 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.<br>Vibration Receptors have been categorised as high sensitivity where the receptors are listed buildings or Scheduled Monuments. |

| Sensitivity | Definition | Examples |
|---|---|---|
| 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.<br>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.<br>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.<br>Such subgroups include offices, shops, outdoor amenity areas, long distance footpaths, doctor's surgeries, sports facilities and places of worship.<br>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.<br>Such subgroups include warehouses, light industry, car parks, and agricultural land.<br>Vibration Receptors have been categorised as negligible sensitivity where vibration is not expected to be detrimental. |

108. The closest human receptors to the project were determined during consultation with relevant stakeholders. Indicative NSRs are detailed in Table 25.26.

109. For each identified receptor or group of receptors a representative location was chosen for the purpose of the assessment as detailed on Figure 25.2 and in Table 25.26.

110. Since PEIR some adaptations to the project design and onshore cable route have been made which have made some receptor locations redundant. In order 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.

111. Additionally, the need for a CRS has been removed from the project since the commitment to HVDC technology. The onshore cable route will still travel through the zone previously identified for the CRS and for the purpose of assessing the noise impacts relating to construction of the onshore cable route these receptor locations have been retained and referred to as the CRS zone.

**Table 25.26 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** | | | | |
| **CRR1** | Residential | Medium | 629201 | 331557 |
| **CRR2** | Residential | Medium | 628619 | 331677 |
| **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 |

| Receptor Identifier | Receptor Classification | Receptor Sensitivity | British National Grid Coordinates | |
|---|---|---|---|---|
| | | | X | Y |
| **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 |
| **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 |
| **CRS Zone** | | | | |
| **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 |

| Receptor Identifier | Receptor Classification | Receptor Sensitivity | British National Grid Coordinates | |
|---|---|---|---|---|
| | | | X | Y |
| **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 |
| **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

112. 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 25.27.

**Table 25.27 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

113. 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 25.28 and will be used wherever relevant.

**Table 25.28 Impact significance matrix**

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

114. For example, in terms of PPG guidance, an Unacceptable Adverse Effect Level (UAEL) is considered to align with a major/high impact in Table 25.29 for a medium sensitivity receptor.

115. 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 25.29 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.<br><br>PPG - Unacceptable Adverse Effect (UAE) |
| Moderate | Intermediate change in receptor condition, which are likely to be important considerations at a local level.<br><br>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.<br><br>PPG – Observed Adverse Effect (OAE) |
| Negligible | No discernible change in receptor condition.<br><br>PPG – Lowest Observed Adverse Effect (LOAEL) |
| No impact | No change, therefore no impact to receptor condition.<br><br>PPG – No Observed Effect (NOEL) |

116. Note that for the purposes of this ES, major and moderate impacts are deemed 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.

117. 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

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

119. For further details of the methods used for the CIA for noise and vibration, see section 25.8.7.

### 25.4.3 Transboundary Impact Assessment

120. 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

121. In order to characterise the existing noise climate within the Norfolk Vanguard study area a baseline noise survey was undertaken at locations representative of the nearest sensitive receptors as agreed with the relevant local authorities at the ETG meetings (detailed in Traffic Table 25.26). Measurements were conducted between 27th April and 24th May 2017.

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

### 25.5.1 Survey Practice

123. 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.

124. 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' Sound Level Meter (SLM).

125. 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.

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

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

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

128. 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.

129. 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

130. 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 had been previously agreed with all relevant local authorities.

131. The background noise levels for the unattended measurement periods were assessed using statistical analysis of the measured $L_{A90}$ values.

132. 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.

### 25.5.3 Anticipated Trends in Baseline Conditions

133. The baseline noise survey detailed in section 25.5 and Appendix 25.1 provides a clear representation of the existing soundscape within the study area of the project. Noise is managed and driven by 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 section 25.2. 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 25.2.2.2. 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.

## 25.6 Scope

### 25.6.1 Study Area

134. The onshore project area considered includes the following elements:

- Landfall;
- Onshore cable route, accesses, trenchless crossing (e.g. Horizontal Directional Drilling (HDD)) zones, transition pit and mobilisation areas;
- Onshore project substation; and
- Extension to the Necton National Grid substation and overhead line modification.

135. As agreed with stakeholders during the ETG meetings and discussed in section 25.4.1.3, 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 noise sources within the National Grid extension during normal operation, the National Grid substation extension and overhead line modifications are not considered further within this assessment.

136. For the purposes of the assessment, and to aid the baseline descriptions, the study area has been defined to assess the direct and indirect impacts associated with the project. The study area is shown in Figure 25.1 and Figure 25.2.

137. Engineering design, route refinement, and additional information was sought for the onshore cable route, mobilisation areas and trenchless crossing zones (e.g. HDD) during the assessments undertaken for the project. The noise and vibration assessment draws on the information provided within Chapter 5 Project Description

in order to define a worst case scenario, which is subsequently assessed in this chapter.

### 25.6.2 Data Sources

138. A desk-based assessment was undertaken which used existing available geographical information to identify NSRs and noise sources present within the study area.

139. Consideration of the project and surrounding environment was conducted initially using aerial and satellite photography and mapping data in order to determine the nearest noise sensitive receptors for use in the assessment.

140. 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 the following local authorities:

- North Norfolk District Council (NNDC);
- Broadland District Council (BDC);
- Breckland Council (BC); and
- Norwich District Council (NDC).

141. The extent of the study area for the construction phase road traffic noise and vibration assessment was based on details provided in Chapter 24 Traffic and Transport and as a result of traffic-specific ETG meetings and PEIR consultation.

142. 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. Furthermore, the proximity of NSRs to the 200m onshore cable corridor and search areas (defined in the project method statement) formed the basis of identifying existing and future NSR's for inclusion in the assessment.

143. Full details of the baseline noise survey are discussed in section 25.5 and Appendix 25.1.

144. The data sources used and the confidence levels associated with them which informed the desk-based assessment are provided in Table 25.30.

**Table 25.30 Data sources**

| Data | Year | Coverage | Confidence |
|---|---|---|---|
| Google Maps Aerial Photography | 2016 | 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 | 2018 | Landfall:<br>• Duct installation; and<br>• Cable pull, joint and commission.<br>Onshore cable route:<br>• Preconstruction works;<br>• Duct installation works; and<br>• Cable pull, joint and commission.<br>Onshore project substation:<br>• Preconstruction works; and<br>• Primary works.<br>National Grid substation extension. | High |
| Operational | 2018 | Onshore project substation | High |

## 25.7 Existing Environment

145. 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 likely to be:

- 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.

146. 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 noise background levels in the area. 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.

## 25.8 Potential Impacts

147. 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.

### 25.8.1 Embedded Mitigation

148. Norfolk Vanguard Limited has committed to a number of techniques and engineering designs/modifications inherent 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.

149. 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 5 Project Description, Chapter 4 Site Selection and Assessment of Alternatives and the Consultation Report (document reference 5.1)) including engineering requirements, feedback from communities and landowners, ongoing discussions with stakeholders and regulators, commercial considerations and environmental best practice.

150. Table 25.31 outlines the key embedded mitigation relevant for this assessment. Any further mitigation measures suggested within this chapter are therefore considered to be in-addition. 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 25.32.

151. Note that design work for the onshore project substation is ongoing and the development of a final noise mitigation strategy, in consultation with Breckland Council, will be completed at detailed design stage. 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 25.31 Embedded mitigation**

| Parameter | Mitigation measures embedded into the project design | Notes |
|---|---|---|
| Strategic approach to delivering Norfolk Vanguard and Norfolk Boreas | Subject to both Norfolk Vanguard and Norfolk Boreas receiving development consent and progressing to construction, 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.<br>In accordance with the Horlock Rules, the co-location of Norfolk Vanguard and Norfolk Boreas 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 Vanguard and Norfolk Boreas has been a consideration from the outset. |
| Commitment to HVDC technology | Commitment to HVDC technology minimises environmental impacts through the following design considerations;<br>• HVDC requires fewer cables than the HVAC solution. During the duct installation phase this reduces the cable route working width (for Norfolk Vanguard and Norfolk Boreas combined) to 45m from the previously identified worst case of 100m. As a result, the overall footprint of the onshore cable route required for the duct installation phase is reduced from approx. 600ha to 270ha;<br>• The width of permanent cable easement is also reduced from 54m to 20m;<br>• Removes the requirement for a CRS;<br>• Reduces the maximum duration of the cable pull phase from three years down to two years;<br>• Reduces the total number of jointing bays for Norfolk Vanguard from 450 to 150; and<br>• Reduces the number of drills needed at trenchless crossings (including landfall). | Norfolk Vanguard 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 National Grid infrastructure, a preference for the shortest route length (where practical) and developing construction methodologies to minimise potential impacts.<br>Key design principles from the outset were followed | 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 Vanguard Limited has reviewed consultation received to inform the site selection |

| Parameter | Mitigation measures embedded into the project design | Notes |
|---|---|---|
| | (wherever practical) and further refined during the EIA process, including;<br>• Avoiding proximity to residential dwellings;<br>• Avoiding proximity to historic buildings;<br>• Avoiding designated sites;<br>• Minimising impacts to local residents in relation to access to services and road usage, including footpath closures;<br>• Utilising open agricultural land, therefore reducing road carriageway works;<br>• Minimising requirement for complex crossing arrangements, e.g. road, river and rail crossings;<br>• Avoiding areas of important habitat, trees, ponds and agricultural ditches;<br>• Installing cables in flat terrain maintaining a straight route where possible for ease of pulling cables through ducts;<br>• Avoiding other services (e.g. gas pipelines) but aiming to cross at close to right angles where crossings are required;<br>• Minimising the number of hedgerow crossings, utilising existing gaps in field boundaries;<br>• Avoiding rendering parcels of agricultural land inaccessible; and<br>• Utilising and upgrading existing accesses where possible to avoid impacting undisturbed ground. | process (including 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. |
| Duct Installation Strategy | The onshore cable duct installation strategy is proposed to be conducted in a sectionalised approach in order to minimise impacts. Construction teams would work on a short length (approximately 150m section) and once the cable ducts have been installed, the section would be back filled and the top soil replaced 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 project commitment from the outset in response to lessons learnt on other similar NSIPs. Chapter 5 Project Description provides a detailed description of the process. |
| 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 Vanguard Limited have also agreed to not use the beach car park at Happisburgh South. | Norfolk Vanguard 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. |
| Trenchless Crossings | Commitment to trenchless crossing techniques to | A commitment to a |

| Parameter | Mitigation measures embedded into the project design | Notes |
|---|---|---|
| | minimise impacts to the following specific features;<br>• Wendling Carr County Wildlife Site;<br>• Little Wood County Wildlife Site;<br>• Land South of Dillington Carr County Wildlife Site;<br>• Kerdiston proposed County Wildlife Site;<br>• Marriott's Way County Wildlife Site / Public Right of Way (PRoW);<br>• Paston Way and Knapton Cutting County Wildlife Site;<br>• Norfolk Coast Path;<br>• Witton Hall Plantation along Old Hall Road;<br>• King's Beck;<br>• River Wensum;<br>• River Bure;<br>• Wendling Beck;<br>• Wendling Carr;<br>• North Walsham and Dilham Canal;<br>• Network Rail line at North Walsham that runs from Norwich to Cromer;<br>• Mid-Norfolk Railway line at Dereham that runs from Wymondham to North Elmham; and<br>• Trunk Roads including A47, A140, A149. | number of trenchless crossings at certain sensitive locations was identified at the outset. However, Norfolk Vanguard Limited has committed to certain additional trenchless crossings as a direct response to stakeholder requests. |

**Table 25.32 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 25.9.2 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 (e.g. monthly) 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 25.9.2 for more details on potential impacts during operation. |

### 25.8.2 Worst Case

152. 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.

153. It is anticipated that Norfolk Boreas Limited will progress the development of the Norfolk Boreas Offshore Wind Farm. Consideration has been made in the assessment such that the onshore cable route for the project accommodates ducts for the future Norfolk Boreas Offshore Wind Farm onshore cable route. This concept avoids reopening cable trenches.

154. The onshore project substation will consist of up to two HVDC converter stations.

155. The onshore project substation converts the HVDC electrical power from the Norfolk Vanguard export connection to the 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.

156. For the purposes of assessing the onshore project substation, the scenario 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 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.

157. 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.

158. During duct installation, the assessment assumes ducts are installed for Norfolk Vanguard and Norfolk Boreas at the same time, equivalent to a maximum of four trenches to accommodate four circuits.

159. 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.

### 25.8.3 Assumptions and Limitations

160. 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).

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

#### 25.8.3.1 Construction Assumptions

162. 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 0700hrs and 1900hrs Monday to Friday and between 0700hrs and 1300hrs on Saturday;
- For the purposes of this assessment it was assumed that construction activities that may require 24hrs working would be at the landfall only due to the Long HDD requirement;
- 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 trenchless drilling operations as the plant requirement is more onerous and therefore worst case;
- 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; and

- Acoustic propagation effects were calculated using the BS 5228 methodology which takes into account distance attenuation, barriers and ground absorption.

163. 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.

#### 25.8.3.2 Operation Phase Assumptions

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

- All onshore assets modelled as HVDC options;
- No 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 1$^{st}$ floor level (+4.5m) considered representative of both daytime and night time, resting and amenity space; and
- Acoustic propagation effects were calculated using the ISO9613-2 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.

165. The results of the calculation are presented as the dB $L_{Aeq,T}$ noise level covering the daytime (0700hrs to 2300hrs) and night time (2300hrs to 0700hrs) reference periods representing a conservative prediction of the noise level that might affect adjacent receptors during operation of the onshore assets.

### 25.8.4 Assessment Scenarios

166. Chapter 5 Project Description outlines the scenarios to be assessed in relation to the phasing of the works. The phasing of the construction works is as follows:

- The offshore project may be constructed as one or two phases and elements of the onshore construction would also be phased to reflect this;
- Pre-construction works (e.g. hedgerow clearance) for the onshore cable route to be conducted over a two year period, prior to duct installation;

- Cable ducts would be installed in one operation over two years, regardless of the offshore strategy;
- Cable pull through would be done in either one or two phases;
- The onshore project substation ground preparation and enabling works would be done in one phase, anticipated to take two years for pre-construction works and two years for primary works;
- The required electrical infrastructure and plant within the onshore project substation would then be installed as required for each phase if the one or two phase options were adopted for offshore construction; and
- Total construction window for the one phase scenario is anticipated to be five years, and six years for the two phase scenario.

### 25.8.5 Potential Impacts during Construction

167. This section presents a worst case overview of potential noise and vibration impacts associated with the construction of the project.

#### 25.8.5.1 Noise

168. The results of the daytime weekday (0700hrs to 1900hrs) and Saturday (0700hrs to 1300hrs) noise propagation calculations are presented in Appendix 25.2 and shown on Figure 25.2. 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 long HDD operations. The noise levels are based on the assumptions and approach detailed in section 25.4.

169. 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.

170. Table 25.33 details a summary of the potential construction noise impacts at the agreed receptor locations. Impact magnitudes have been assessed in accordance with the criteria detailed within Table 25.6 and the significance criteria detailed in Table 25.28.

171. 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.

172. The assessment of construction generated noise has predicted potential significant adverse impacts under the worst case scenario. It should be noted that the most significantly noisy construction activities within the onshore cable route adjacent to each respective receptor will be of relatively short duration as the active workfronts

progress along the onshore cable route. HGV and dump truck movements along the running track however, will continue throughout the construction phase.

173. Figure 25.2 map 9 shows two areas (closest receptors SSR4 and SSR3) where there are options for the onshore cable route to split in a northern or southern direction before entering the onshore project substation. Based on Figure 25.2 (heading in a west to east direction), there are four potential optional scenarios for construction noise modelling:

- Option 1: northern and northern route;
- Option 2: northern and southern route;
- Option 3: southern and northern route; and
- Option 4: southern and southern route.

174. Table 25.33 details only the predicted daytime worst case construction phase noise levels for these four options.

*25.8.5.1.1 Best practice mitigation*

175. 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 ES chapter and assessment, a 5dB(A) reduction only was applied to represent the effect of incorporating these mitigation measures.

176. Table 25.33 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).

177. During the daytime period, predicted levels (including standard mitigation) are below the BS 5228 derived thresholds for the majority of assessed receptors, with the exception of onshore cable route receptors CRR10, CRR1E, CRR3F during Preconstruction works; CRR2, CRR10, CRR1E, CRR3F during duct installation works; and CRR10, CRR1E, CRR3F during cable pull, joint and commission. 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 are likely to be more mobile within the onshore cable route.

*25.8.5.1.2 Pre-construction*

178. During pre-construction works the magnitude of effect, after standard mitigation, was assessed as major at medium sensitivity receptors CRR10, CRR1E, CRR3F (detailed in Table 25.33); using the significance matrix detailed in Table 25.28, this represents a **major adverse** impact. Enhanced mitigation measures are detailed in section 25.8.5.7 of this chapter

179. During the pre-construction works the magnitude of effect, after standard mitigation, outlined in the CoCP (DCO requirement 20), was assessed as negligible at medium sensitivity receptor SSR4; using the significance matrix detailed in Table 25.28, this represents a **minor adverse** impact.

*25.8.5.1.3 Duct installation*

180. During duct installation works the magnitude of effect, after standard mitigation, was assessed as negligible to major at medium sensitivity receptors CRR2, CRR10, CRR1E, CRR3F (detailed in Table 25.33); using the significance matrix detailed in Table 25.28, this represents **minor** to **major adverse** impacts. Enhanced mitigation measures are detailed in section 25.8.5.7 of this chapter.

181. During the duct installation and primary works phase the magnitude of effect, after standard mitigation, was assessed as minor at medium sensitivity receptor SSR4; using the significance matrix detailed in Table 25.28, this represents a **minor adverse** impact.

*25.8.5.1.4 Cable pull, joint and commission works*

182. During cable pull, joint and commission works the magnitude of effect, after standard mitigation, was assessed as moderate to major at medium sensitivity receptors CRR10, CRR1E, CRR3F (detailed in Table 25.33); using the significance matrix detailed in Table 25.28, this represents **moderate** to **major adverse** impacts. Enhanced mitigation measures are detailed in section 25.8.5.7 of this chapter.

183. During cable pull, joint and commission works the magnitude of effect was assessed as no impact at medium sensitivity receptors near the onshore project substation (shown on Figure 25.2); using the significance matrix detailed in Table 25.28, this represents a **negligible** impact.

184. For the onshore project substation and National Grid substation extension receptors, only receptor SSR4 (detailed on Figure 25.2) will require up to 1.2dB(A) enhanced mitigation (details of which are contained within section 25.8.5.7) during the duct installation and primary works phase. It should be noted that Options 3 and 4 (detailed in paragraph 173) predict noise levels lower than the BS5228 threshold of 65dB(A); therefore removing the requirement for enhanced mitigation.

*25.8.5.1.5 Enhanced mitigation*

185. Based on the worst case construction assumptions, enhanced mitigation measures will only be required at some receptors (details of which are contained within section 25.8.5.7 and Table 25.33). After enhanced mitigation measures are applied, the residual impacts at all sensitive receptors will be **negligible** using the significance matrix detailed in Table 25.28.

### Table 25.33 Construction noise impacts – daytime

| Phase | BS5228 Threshold dB(A) | Predicted noise level $L_{Aeq, 12hr}$ dB (Standard mitigation applied) | Impact Magnitude (Standard mitigation only) | Required Enhanced Mitigation (Yes/No) and range dB(A) | Residual Impact |
|---|---|---|---|---|---|
| **Landfall receptors** | | | | | |
| Preconstruction Works | **65** | **34.9 to 50.5** | No Impact | No | No Impact with standard mitigation |
| Duct Installation | **65** | **44.3 to 47.8** | No Impact | No | No Impact with standard mitigation |
| Cable Pull, joint and Commission | **65** | **34.1 to 49.3** | No Impact | No | No Impact with standard mitigation |
| **Onshore cable route receptors** | | | | | |
| Preconstruction Works | **65** | **29.9 to 65.0** | No Impact | No | No Impact 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** | **>65.0 to 76.6** | Major Impact | Yes (Noise reduction of 7.0 to 11.6 required) | No Impact with enhanced mitigation |
| Duct Installation | **65** | **32.9 to 65.0** | No Impact | No | No Impact with standard mitigation |
| Only 4 NSR locations where duct installation works may result in impact which require enhanced mitigation Threshold Category A (65) Exceeded at CRR2, CRR10, CRR1E, CRR3F). | **65** | **>65.0 to 72.3** | Negligible to Major | Yes (Noise reduction of 0.6 to 7.3 required) | No Impact with enhanced mitigation |
| Cable Pull, joint and Commission | **65** | **28.6 to 65.0** | No Impact | No | No Impact with standard mitigation |
| Only 3 NSR locations where Cable Pull, joint and commission impacts may result in enhanced mitigation Threshold Category A (65) Exceeded at CRR10, CRR1E, CRR3F). | **65** | **>65.0 to 75.0** | Moderate to Major | Yes (Noise reduction of 3.0 to 10.0 required) | No Impact with enhanced mitigation |
| **Onshore project substation and National Grid extension receptors** | | | | | |

| Phase | BS5228 Threshold dB(A) | Predicted noise level $L_{Aeq, 12hr}$ dB (Standard mitigation applied) | Impact Magnitude (Standard mitigation only) | Required Enhanced Mitigation (Yes/No) and range dB(A) | Residual Impact |
|---|---|---|---|---|---|
| Preconstruction Works | **65** | **33.7 to 65.0** | No Impact | No | No Impact with standard mitigation |
| Only 1 NSR location where pre-construction works may result in impact which requires enhanced mitigation (Threshold Category A (65) Exceeded at SSR4 using the Cable route Option 1 and Option 2 only). | **65** | **>65.0 to 65.1** | Negligible Impact | Yes (Noise reduction of 0.1 required) | No Impact with enhanced mitigation |
| Duct Installation + Primary Works | **65** | **39.5 to 65.0** | No Impact | No | No Impact with standard mitigation |
| Only 1 NSR location where duct installation works may result in impact which requires enhanced mitigation (Threshold Category A (65) Exceeded at SSR4 using the Cable route Option 1 and Option 2 only). | **65** | **>65.0 to 66.2** | Minor Impact | Yes (Noise reduction of 1.2 required) | No Impact with enhanced mitigation |
| Cable Pull, joint and Commission | **65** | **33.7 to 64.3** | No Impact | No | No Impact 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 and Section 25.8.3.4. Specific construction mitigation measures will be agreed during the detailed design stage. | | | | | |

### 25.8.5.2 Landfall – Evening and Weekends

186. There may be the requirement to undertake construction activity over a 24 hour/7 day week programme at the landfall only due to the long HDD operations. Table 25.25.34 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 25.7 and the significance criteria detailed in Table 25.28.

187. 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.

188. The magnitude of effect was assessed as no impact (in accordance with criteria in Table 25.6) at all landfall receptors (which were assigned a medium sensitivity); using the significance matrix detailed in Table 25.28, this results in a **negligible** impact.

**Table 25.25.34 Construction noise impacts – evening and weekends**

| Phase | BS5228 Noise Threshold dB(A) | Predicted noise level $L_{Aeq, 12hr}$ dB (Standard mitigation applied) | Impact Magnitude (Standard mitigation only) | Required Enhanced Mitigation (Yes/No) and range dB(A) | Residual Impact Magnitude |
|---|---|---|---|---|---|
| **Landfall receptors** | | | | | |
| Preconstruction Works | **55** | **34.9 to 50.5** | No Impact | No | No Impact with standard mitigation |
| Duct Installation | **55** | **44.3 to 47.8** | No Impact | No | No Impact with standard mitigation |
| Cable Pull, joint and Commission | **55** | **34.1 to 49.3** | No Impact | No | No Impact 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 and Section 25.8.3.4. Specific construction mitigation measures will be agreed during the detailed design stage. | | | | | |

### 25.8.5.3 Landfall – Night-time

189. Table 25.35 details a summary of the potential construction noise impacts at the agreed landfall receptor locations during the night time period. Impact magnitudes have been assessed in accordance with the criteria detailed within Table 25.8 and the significance criteria detailed in Table 25.28.

190. 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). Based on the worst case

construction phase assumptions, enhanced mitigation measures will be required at this receptor. Enhanced mitigation measures are detailed in section 25.8.5.7 of this chapter.

191. The magnitude of effect was assessed as no impact at the majority of landfall (medium sensitivity) receptors; using the significance matrix detailed in Table 25.28, this represents a **negligible** impact.

192. Medium sensitivity receptor LFR2H was assessed as a major, minor and moderate adverse impact range during pre-construction, duct installation, and cable pull, respectively; using the significance matrix detailed in Table 25.28, this represents **minor** to **major adverse** impacts.

193. Based on the worst case construction phase assumptions, enhanced mitigation measures will only be required at this receptor (details of which are contained within section 25.8.5.7) The residual impact after enhanced mitigation measures are applied will be negligible using the significance matrix detailed in Table 25.28, resulting in a **negligible** impact on a medium sensitivity receptor.

**Table 25.35 Construction noise impacts – night time**

| Phase | BS5228 Noise Threshold dB(A) | Predicted noise level $L_{Aeq, 12hr}$ dB (Standard mitigation applied) | Impact Magnitude (Standard mitigation only) | Required Enhanced Mitigation (Yes/No) and range dB(A) | Residual Impact Magnitude |
|---|---|---|---|---|---|
| **Landfall receptors** | | | | | |
| Preconstruction Works | **45** | **34.9 to 45.0** | No Impact | No | No Impact with standard mitigation |
| Only 1 NSR locations where pre-construction works may result in impact which require enhanced mitigation (Threshold Category A (45) Exceeded at LFR2H). | **45** | **>45 to 50.5** | Major Impact | Yes (Noise reduction of 5.5 required) | No Impact with enhanced mitigation |
| Duct Installation | **45** | **44.3 to 45.0** | No Impact | No | No Impact with standard mitigation |

| Phase | BS5228 Noise Threshold dB(A) | Predicted noise level $L_{Aeq, 12hr}$ dB (Standard mitigation applied) | Impact Magnitude (Standard mitigation only) | Required Enhanced Mitigation (Yes/No) and range dB(A) | Residual Impact Magnitude |
|---|---|---|---|---|---|
| Only 1 NSR location where duct installation works may result in impact which requires enhanced mitigation (Threshold Category A (45) Exceeded at LFR2H). | **45** | **>45 to 47.8** | Minor Impact | Yes (Noise reduction of 2.8 required) | No Impact with enhanced mitigation |
| Cable Pull, joint and Commission | **45** | **34.1 to 45.0** | No Impact | No | No Impact |
| Only 1 NSR location where Cable Pull, joint and commission impacts may result in enhanced mitigation (Threshold Category A (45) Exceeded at LFR2H). | **45** | **>45 to 49.3** | Moderate Impact | Yes (Noise reduction of 4.3 required) | No Impact 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. | | | | | |

### 25.8.5.4 Vibration

194. 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 towers adjacent to the National Grid substation extension and potentially at landfall and trenchless crossing zones (e.g. HDD) to temporarily anchor the drilling rigs along the onshore cable route.

195. The closest receptor locations to the onshore project substation are SSR2 and SSR4 which are approximately 750m away. In accordance with Table 25.17, at a setback distance of 750m it is considered that any vibration levels would not be perceptible at receptor locations.

196. The closest receptor location to the National Grid overhead line tower installation zone is SSR5 which is approximately 230m away. In accordance with Table 25.17, 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.

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

198. 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.

199. 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.

200. 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 rigs required at trenchless crossing zones (e.g. HDD) and landfall will need to be located subject to vibration criteria.

201. 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 25.18 details indicative vibration levels from various piling methods with regards to buildings of differing architectural merit.

202. 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 represents a no impact magnitude of effect; for a medium sensitivity receptor (using the significance matrix detailed in Table 25.28), this represents **no impact**.

#### 25.8.5.5 Road Traffic Noise Emissions

203. 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.

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

205. Traffic impacts were assessed for the construction phase years of 2022 and 2023 (as per the programme details in Chapter 24 Traffic and Transport), taking base flows, annual growth and project-generated construction traffic into consideration.

206. Relative change in ambient noise as a result of construction road traffic emissions is not expected to increase by greater than 3.5dB in either 2022 or 2023 on any associated road links. In accordance with the DMRB criteria detailed in Table 25.15, it is anticipated that project generated construction traffic will have at most a **moderate adverse** impact (Link 21 and 25, see Appendix 25.2), with most links experiencing **no** or a **negligible impact**.

207. Construction road traffic emissions are anticipated to result in at most a temporary and reversible, **moderate adverse** impacts at two road links, in accordance with the impact significance matrix detailed in Table 25.28, and based on the medium sensitivity of the residential receptors in the vicinity of the road links.

208. Chapter 24 Traffic and Transport outlines the concept of a TMP (DCO requirement 21). Through the development of a TMP, Norfolk Vanguard 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 the TMP.

#### 25.8.5.6 Standard Mitigation

209. 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) within the CoCP (DCO requirement 20). A summary of the measures is set out in the following sections.

##### *25.8.5.6.1 Construction Noise Management Plan*

210. 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.

211. Although the effect of adopting such methods cannot be precisely quantified, it is possible that these methods would reduce noise levels by between 5 - 10dB(A). In order to provide a conservative approach, the construction phase assessment has assumed a 5dB(A) reduction for incorporating these mitigation measures.

*25.8.5.6.2 Training of construction staff*

212. 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.

213. 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.

*25.8.5.6.3 Maintenance of construction plant*

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

215. 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*

216. During the daytime period, predicted impacts (including standard mitigation) at onshore cable route receptors CRR10, CRR1E, CRR3F during pre-construction works were **major adverse**; at CRR2, CRR10, CRR1E, CRR3F during duct installation works **negligible** to **major adverse**; and at CRR10, CRR1E, CRR3F during cable pull, joint and commission were **moderate** to **major adverse**.

217. For the onshore project substation and National Grid substation extension works receptor SSR4 was predicted a **negligible** impact during pre-construction, and a **minor adverse** impact during the duct installation and primary works phases.

218. In order to ensure these impacts are mitigated as far as reasonably possible, the aforementioned standard mitigation (also detailed in the CoCP (DCO requirement 20)), coupled with more site specific solutions such as the use of screening such as temporary noise barriers and/or temporary spoil bunds, would be applied. The residual magnitude of effect after enhanced mitigation measures are applied will be negligible on a medium sensitive receptor. Using the significance matrix detailed in Table 25.28 this represents a **negligible** impact.

219. 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."*

#### *25.8.5.7.2 Construction plant mitigation*

220. 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.

221. 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. Further details are provided in the OCoCP (document reference 8.1).

222. Initial calculations determined that with the application of standard mitigation measures (detailed in the CoCP (DCO requirement 20)) and an increased separation

distance, would ensure that the BS 5228 daytime construction noise thresholds are not exceeded at CRR2, CRR10, CRR1E, CRR3F.

223. It should be noted that Options 3 and 4 for the onshore cable route (detailed in paragraph 174) predict daytime noise levels at SSR4 below the BS5228 threshold of 65dB(A); therefore removing the requirement for enhanced mitigation.

224. With the incorporation of enhanced mitigation measures, it is predicted that the magnitude of effect (and therefore the residual impact) will reduce to no impact/negligible for all medium sensitivity receptors during all phases of construction; using the significance matrix detailed in Table 25.28, this represents a **negligible** impact.

### 25.8.6 Potential Impacts during Operation

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

#### 25.8.6.1 Noise

226. 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.

227. 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.

228. 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 receptor locations around the onshore project substation is dominated principally by road traffic noise from the A47.

229. Calculated operational noise levels have been determined at GF – Ground Floor and 1$^{st}$ 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.

230. The magnitude of effects has been assessed in accordance with BS 4142:2014 derived thresholds, detailed within Table 25.20, and the significance criteria detailed in Table 25.28.

231. An assessment of the 35dB(A) condition and 32dBZ 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 Necton substation.

232. Table 25.36 contains a summary of the potential unmitigated operational noise impacts, associated with the onshore project infrastructure at the agreed receptor locations. No BS 4142:2014 character penalties have been applied.

233. A contour isopleth showing the predicted unmitigated operational noise from Norfolk Vanguard is detailed in Appendix 25.3, Plate 25.2.

**Table 25.36 Norfolk Vanguard worst case operational noise impacts**

| 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) | 21.7 | 25.0 | 37.7 | 33.8 | No Impact | |
| | FF (First Floor) | 23.0 | 25.0 | 37.7 | 33.8 | No Impact | Yes |
| SSR2 | GF | 27.1 | 31.1 | 32.2 | 28.4 | No Impact | Yes |
| | FF | 30.2 | 32.0 | 32.2 | 28.4 | Negligible | Yes |
| SSR3 | GF | 20.3 | 24.1 | 32.2 | 28.4 | No Impact | Yes |
| | FF | 21.9 | 24.5 | 32.2 | 28.4 | No Impact | Yes |
| SSR4 | GF | 21.4 | 29.2 | 31.0 | 22.9 | No Impact | Yes |
| | FF | 22.5 | 29.5 | 31.0 | 22.9 | No Impact | Yes |
| SSR5 | GF | 24.1 | 26.7 | 50.5 | 29.9 | No Impact | Yes |
| | FF | 26.5 | 27.4 | 50.5 | 29.9 | No Impact | Yes |
| SSR6 | GF | 13.7 | 23.0 | 36.0 | 28.6 | No Impact | Yes |
| | FF | 14.9 | 23.1 | 36.0 | 28.6 | No Impact | Yes |
| SSR7 | GF | 24.2 | 30.1 | 46.3 | 39.4 | No Impact | Yes |
| | FF | 24.9 | 30.3 | 46.3 | 39.4 | No Impact | Yes |
| SSR8 | GF | 19.4 | 26.6 | 58.4 | 36.8 | No Impact | Yes |
| | FF | 20.2 | 26.7 | 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 | | |
| SSR9 | GF | 14.2 | 23.4 | 36.5 | 32.2 | No Impact | Yes |
| | FF | 17.5 | 24.4 | 36.5 | 32.2 | No Impact | Yes |
| SSR10 | GF | 25.1 | 28.4 | 34.0 | 21.8 | Minor | Yes |
| | FF | 25.8 | 28.4 | 34.0 | 21.8 | Minor | Yes |
| SSR11 | GF | 24.2 | 26.6 | 56.5 | 31.3 | No Impact | Yes |
| | FF | 26.3 | 27.3 | 56.5 | 31.3 | No Impact | Yes |
| | | BS4142 Criteria Met or 32dBZ 100Hz Requirement Met | | | | | |
| | | BS4142 Criteria Exceeded or 32dBZ 100Hz Requirement Exceeded | | | | | |

234. Table 25.36 (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 32dBZ(100hz) limit and result in, at most, effects of **minor** magnitude at identified receptor locations in accordance with BS4142:2014 derived impact magnitudes. Using the significance matrix detailed in Table 25.28, at a medium sensitivity receptor, a **minor adverse** impact is predicted.

### 25.8.6.2 Mitigation

235. 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 DCO requirement 27. Suitable mitigation measures will be identified to deliver the required noise reduction to ensure that noise emissions will not exceed the permitted noise levels of the existing Necton substation, specifically:

- The noise rating level (defined as set out in BS4142) 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 32dB $L_{Leq\ (15\ minutes)}$ in the 100Hz third octave band, at any time at a free field location immediately adjacent to any noise sensitive location.

236. 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 what has been assessed here.

237. 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).

238. Norfolk Vanguard 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.

239. 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.

240. Table 25.37 details the performance requirement for an example of suitable mitigation which would result in compliance with the requirements (conditions) of Breckland Council.

241. 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 25.37 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 | - |
| **500** | 37.6 | 41.7 | 51.7 | 56.7 |
| **630** | 35 | - | 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 | - | 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 | |

242. Table 25.38 details the results of the mitigated modelling exercise, which show that the onshore project substation, with the application of additional noise mitigation

measures will fall within the 32dBZ(100hz) 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 25.28, at all sensitive onshore project substation receptors, a **negligible** impact is predicted.

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

**Table 25.38 Mitigated operational noise impacts**

| 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) | 11.0 | 22.5 | 37.7 | 33.8 | No Impact | Yes |
| | FF (First Floor) | 11.8 | 22.6 | 37.7 | 33.8 | No Impact | Yes |
| SSR2 | GF | 16.3 | 28.3 | 32.2 | 28.4 | No Impact | Yes |
| | FF | 18.3 | 29.0 | 32.2 | 28.4 | No Impact | Yes |
| SSR3 | GF | 9.2 | 21.6 | 32.2 | 28.4 | No Impact | Yes |
| | FF | 10.4 | 22.0 | 32.2 | 28.4 | No Impact | Yes |
| SSR4 | GF | 14.3 | 27.2 | 31.0 | 22.9 | No Impact | Yes |
| | FF | 15.0 | 27.4 | 31.0 | 22.9 | No Impact | Yes |
| SSR5 | GF | 12.0 | 24.2 | 50.5 | 29.9 | No Impact | Yes |
| | FF | 14.0 | 24.8 | 50.5 | 29.9 | No Impact | Yes |
| SSR6 | GF | 7.4 | 20.7 | 36.0 | 28.6 | No Impact | Yes |
| | FF | 7.7 | 20.8 | 36.0 | 28.6 | No Impact | Yes |
| SSR7 | GF | 16.1 | 28.8 | 46.3 | 39.4 | No Impact | Yes |
| | FF | 16.5 | 29.1 | 46.3 | 39.4 | No Impact | Yes |
| SSR8 | GF | 11.6 | 24.7 | 58.4 | 36.8 | No Impact | Yes |
| | FF | 12.1 | 24.8 | 58.4 | 36.8 | No Impact | Yes |
| SSR9 | GF | 8.3 | 21.8 | 36.5 | 32.2 | No Impact | Yes |
| | FF | 9.3 | 22.3 | 36.5 | 32.2 | No Impact | Yes |
| SSR10 | GF | 14.4 | 25.8 | 34.0 | 21.8 | 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 | 14.9 | 25.8 | 34.0 | 21.8 | No Impact | Yes |
| SSR11 | GF | 12.9 | 24.3 | 56.5 | 31.3 | No Impact | Yes |
| | FF | 14.5 | 25.0 | 56.5 | 31.3 | No Impact | Yes |
| | | BS4142 Criteria Met or 32dBZ 100Hz Requirement Met | | | | | |
| | | BS4142 Criteria Exceeded or 32dBZ 100Hz Requirement Exceeded | | | | | |

### 25.8.7 Potential Impacts during Decommissioning

244. 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.

245. 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.

246. 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 site located 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.

247. Whilst details regarding the decommissioning of the onshore project substation is currently unknown, considering the worst case scenario 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.

248. 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

249. 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 25.39.

**Table 25.39 Potential cumulative impacts**

| Impact | Potential for cumulative impact | Rationale |
|---|---|---|
| **Construction** | | |
| Other 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 Vanguard and where activities will occur in proximity to the same receptors.<br><br>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. | | |

250. 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.

251. The projects identified for potential cumulative impacts with Norfolk Vanguard have been discussed during ETG meetings with stakeholders and agreed in consultation with local authorities.

252. Table 25.40 summarises those projects which have been scoped into the CIA due to their temporal or spatial overlap with the potential effects arising from the project. The remainder of the section details the nature of the cumulative impacts against all those receptors scoped in for cumulative assessment.

253. For the purposes of assessing the cumulative impacts of the Norfolk Boreas onshore project substation, the scenario 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 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 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.

254. The largest 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, apart from the 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.

255. The assessment methodology and criteria for the construction and operational phases are detailed in Section 25.4.

**Table 25.40 Summary of projects considered for the CIA in relation to the noise and vibration**

| Project | Status | Development period | [1]Distance from Norfolk Vanguard (km) | Project definition | Project data status | Included in CIA | Rationale |
|---|---|---|---|---|---|---|---|
| **National Infrastructure Planning** | | | | | | | |
| Norfolk Boreas Offshore Wind Farm | Pre-Application | Expected construction date 2026 | 0 – projects are co-located | Pre-application outline only | High | Yes | 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. Refer to paragraph 239. |
| Hornsea Project Three Offshore Wind Farm | Pre-Application | Expected construction date 2021 | 0 – cable intersects project | Scoping Report: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-000065-Scoping%20Report.pdf | High | Yes | Overlapping proposed project boundaries may result in impacts of a direct and / or indirect nature during construction where geographical footprints overlap |

[1] Shortest distance between the considered project and Norfolk Vanguard – unless specified otherwise.

| Project | Status | Development period | [1]Distance from Norfolk Vanguard (km) | Project definition | Project data status | Included in CIA | Rationale |
|---|---|---|---|---|---|---|---|
| | | | | PEIR: http://www.dongenergy.co.uk/en/Pages/PEIR-Documents.aspx. | | | and due to noise 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 | Expected construction date 2021-23 | 2.5 | https://infrastructure.planninginspectorate.gov.uk/projects/eastern/a47-north-tuddenham-to-easton/ | 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 a CoCP for the Highways England programme. It is therefore not anticipated that any |
| A47 corridor improvement programme – A47 Blofield to North Burlingham | Pre-application | Expected construction date 2021-22 | 25 | https://infrastructure.planninginspectorate.gov.uk/projects/eastern/a47-blofield-to-north-burlingham/ | Medium | No | |
| A47 corridor | Pre-application | Expected | 18 | https://infrastructur | Medium | No | |

| Project | Status | Development period | [1]Distance from Norfolk Vanguard (km) | Project definition | Project data status | Included in CIA | Rationale |
|---|---|---|---|---|---|---|---|
| improvement programme – A47 / A11 Thickthorn | | construction date 2020-21 | | e.planninginspectorate.gov.uk/projects/eastern/a47a11-thickthorn-junction/ | | | cumulative effects associated with the construction phase will be significant. |
| Norwich Western Link | Pre-application | 2022 | 2.8 | https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/norwich/norwich-western-link/timeline | Medium | No | Potential cumulative impacts could occur related to potentially overlapping construction traffic and its associated noise and vibration implications.<br>Noting the lack of information available at this stage, it is not possible to provide a meaningful assessment of cumulative impacts.<br>It is therefore proposed that, if approved, through the development of the TMP, Norfolk Vanguard Limited and its Contractors would engage stakeholders to try and establish |

| Project | Status | Development period | [1]Distance from Norfolk Vanguard (km) | Project definition | Project data status | Included in CIA | Rationale |
|---|---|---|---|---|---|---|---|
| | | | | | | | opportunities to co-ordinate activities and avoid peak traffic impacts. |
| Third River Crossing (Great Yarmouth) | Pre-application | Expected to start in 2020 | 28 | https://www.norfolk.gov.uk/roads-and-Notransport/major-projects-and-improvement-plans/great-yarmouth/third-river-crossing | Medium | No | 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 | Pre-application | Construction expected 2018-2021 | 28 | https://www.kingslynnbccgt.co.uk/ | Medium | No | Given the large separation distances between the projects it is considered that significant cumulative impacts are not likely to arise. |
| **North Norfolk** | | | | | | | |
| PF/17/1951<br>Erection of 43 dwellings and new access with associated landscaping, highways and external works, and amendments to | Awaiting decision | Anticipated Q2 2018 | 0.7 | Application available: https://idoxpa.north-norfolk.gov.uk/online-applications/applicationDetails.do?active | High | No | It is likely that this development will implement site-specific measures to mitigate noise associated with construction works which would be |

| Project | Status | Development period | [1]Distance from Norfolk Vanguard (km) | Project definition | Project data status | Included in CIA | Rationale |
|---|---|---|---|---|---|---|---|
| substation) | | | | Tab=summary&keyVal=_NNORF_DCAPR_92323 | | | implemented as part of a CoCP for the housing development. It is therefore not anticipated that any cumulative effects associated with the construction phase will be significant. |
| Bacton Gas Terminal Extension | Approved | Approved 20/09/2016. Expires 20/09/2019 | 3.0 | Approved Project Design Statement (PDS) available https://idoxpa.north-norfolk.gov.uk/online-applications/applicationDetails.do?activeTab=summary&keyVal=_NNORF_DCAPR_88689 | 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. |
| Bacton Gas Terminal | Approved | Approved 18/11/2016. Expires | 2.5 | Approved PDS | Medium | No | It is likely that this development will |

| Project | Status | Development period | [1]Distance from Norfolk Vanguard (km) | Project definition | Project data status | Included in CIA | Rationale |
|---|---|---|---|---|---|---|---|
| Coastal Protection | | 18/11/2019 | | available | | | 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. |
| Bacton and Walcott Coastal Management Scheme | Approved | Expected construction date 2018 | 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 |

| Project | Status | Development period | [1]Distance from Norfolk Vanguard (km) | Project definition | Project data status | Included in CIA | Rationale |
|---|---|---|---|---|---|---|---|
| | | | | | | | with the construction phase will be significant. |
| **Breckland** | | | | | | | |
| 21-31 new dwellings in Necton (BLR/2017/0001/PIP) | Awaiting decision | Not known. Application submitted November 2017. | 1.0 | http://planning.breckland.gov.uk/OcellaWeb/showDocuments?reference=BLR/2017/0001/PIP&module=pl | Medium | No | Area of land identified in Necton, on the Old Diner site to be included in the Brownfield register.<br><br>Assessment of impacts from NV and NB undertaken at receptor SSR11 (with a similar soundscape due to proximity to A47). |
| 4-8 new dwellings in Necton (BLR/2017/0002/PIP) | Awaiting decision | Not known. Application submitted November 2017. | 1.0 | http://planning.breckland.gov.uk/OcellaWeb/showDocuments?reference=BLR/2017/0002/PIP&module=pl | Medium | No | Given the large separation distances between this development and sensitive receptors it is considered that significant cumulative impacts are not likely to arise. Assessment of impacts from NV and |

| Project | Status | Development period | [1]Distance from Norfolk Vanguard (km) | Project definition | Project data status | Included in CIA | Rationale |
|---|---|---|---|---|---|---|---|
| | | | | | | | NB undertaken at receptor SSR1 (closer to site than the proposed development detailed here). |
| 70 dwellings (3PL/2016/0298/D) (Phase 2 of 3PL/2012/0576/O) | Approved (21/09/16) | Not known. Application submitted March 2016. | 6.4 | http://planning.breckland.gov.uk/OcellaWeb/planningDetails?reference=3PL/2016/0298/D&from=planningSearch | Medium | No | Given the large separation distances between this development and sensitive receptors it is considered that significant cumulative impacts are not likely to arise. |
| 98 dwellings at Swans Nest with access from Brandon Road (3PL/2017/1351/F) (Phase 3 of 3PL/2012/0576/O) | Awaiting decision (due 30/03/2018) | Not known. Application submitted Jan 2016. | 6.4 | http://planning.breckland.gov.uk/OcellaWeb/planningDetails?reference=3PL/2017/1351/F&from=planningSearch | Medium | No | Given the large separation distances between this development and sensitive receptors it is considered that significant cumulative impacts are not likely to arise. |
| 175 dwellings with access at land to west of Watton Road, Swaffham | Awaiting decision (due 13/10/2017) | Not known. Application submitted Jan 2016. | 6.4 | http://planning.breckland.gov.uk/OcellaWeb/planningDetails?reference=3PL/20 | Medium | No | Given the large separation distances between this development and |

| Project | Status | Development period | [1]Distance from Norfolk Vanguard (km) | Project definition | Project data status | Included in CIA | Rationale |
|---|---|---|---|---|---|---|---|
| (3PL/2016/0068/O) (Swans Nest Phase B) | | | | 16/0068/O | | | sensitive receptors it is considered that significant cumulative impacts are not likely to arise. |

256. As identified in Table 25.40, through one of its subsidiaries, Vattenfall Wind Power Ltd is developing the sister project Norfolk Boreas Offshore Wind Farm (herein 'Norfolk Boreas') to the north of NV East, with the DCO application following approximately one year behind the Norfolk Vanguard DCO application. The development of Norfolk Boreas will use the same onshore cable route as Norfolk Vanguard.

257. The worst case scenario for noise and vibration as set out in section 25.8.2 has assumed that the installation of ducting for the onshore cable route for the Norfolk Boreas project will be conducted as part of the Norfolk Vanguard project construction (as a worst case). Therefore, the only elements of Norfolk Boreas not considered in the assessment conducted in Section 25.8 are the cable pull, onshore project substation and National Grid extension works. Potential cumulative impacts arising from these elements of the Norfolk Boreas project are considered below, alongside all other screened in projects set out in Table 25.40.

258. To avoid confusion between different projects, the Norfolk Vanguard Offshore Wind Farm, previously referred to as 'the project', is referred to as 'Norfolk Vanguard' within this section.

### 25.9.1 Cumulative Impacts during Construction

#### 25.9.1.1 Norfolk Boreas

259. The impacts of road traffic noise at sensitive receptor locations are predicted to have a **moderate adverse** impact. However, it is anticipated that, through the implementation of a TMP (DCO requirement 21), resultant noise contributions will have a **minor adverse** impact**.** Therefore, using the significance matrix detailed in Table 25.28, at a medium sensitivity receptor, a **minor adverse** impact is predicted for Norfolk Vanguard and Norfolk Boreas.

260. The traffic data utilised in the noise and vibration assessment included traffic flows associated with Norfolk Boreas. These are included in the traffic flows detailed in Chapter 24 Traffic and Transport and therefore the cumulative impact results in no change to the worst case assessed impacts as outlined above.

261. The results of the daytime weekday (0700hrs to 1900hrs) and Saturday (0700hrs to 1300hrs) 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.

262. 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.

263. Cumulative construction impacts associated with the construction of Norfolk Boreas onshore project substation and National Grid Extension works in conjunction with the Norfolk Vanguard construction were assessed in accordance with BS5228.

264. The cable pull for the Norfolk Boreas project will be after the cable pull for Norfolk Vanguard has completed. As a worst case, cable pulling has been included for the cumulative construction noise scenarios at the onshore project substation to account for the separate cable installation for each onshore project substation.

265. Effects at representative receptor locations around the onshore project substations and the National Grid substation site have been assessed regarding the following construction works:

- Onshore project substations for both projects;
- 400kV export cable installation;
- Construction of the National Grid substation extensions for both projects; and
- Construction of new towers.

266. Table 25.41 details a summary of the potential construction noise impacts at the agreed receptor locations (including a conservative 5dB(A) allowance for the incorporation of standard mitigation measures).

267. 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. Impact magnitudes have been assessed in accordance with the criteria detailed within Table 25.6 and the significance criteria detailed in Table 25.28.

268. As detailed in section 173 there are options for the route to split in a northern or southern direction before entering the onshore project substation. Table 25.41 details the highest predicted scenario only.

269. During the pre-construction works phase the impact magnitude was assessed as **negligible** at a medium sensitivity receptor SSR4; therefore, using the significance matrix detailed in Table 25.28, this results in a **minor adverse** impact.

270. During the duct installation and primary works phase the impact magnitude was assessed as **minor** at medium sensitivity receptor SSR4; using the significance matrix detailed in Table 25.28, this represents a **minor adverse** impact.

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

within section 25.8.5.7). The residual impact after enhanced mitigation measures are applied will be negligible using the significance matrix detailed in Table 25.28, representing a **negligible** impact at a medium sensitivity receptor.

272. For the onshore project substation and National Grid extension receptors, only receptor SSR4 will require up to 1.2dB(A) enhanced mitigation (details of which are contained within section 25.8.5.7) during the cumulative duct installation and primary works phase. It should be noted that Options 3 and 4 (detailed in paragraph 174) predict noise levels lower than the BS5228 threshold of 65dB(A); therefore, removing the requirement for enhanced mitigation.

**Table 25.41 Worst case cumulative construction noise impacts**

| Phase | Predicted noise level $L_{Aeq, 12hr}$ dB (Standard mitigation applied) | Impact Magnitude (Standard mitigation only) | Required Enhanced Mitigation (Yes/No) and range dB(A) | Residual Impact Magnitude |
|---|---|---|---|---|
| **Onshore project substation and National Grid extension receptors** | | | | |
| Preconstruction Works | **37.1 to 65.1** | No Impact | No | No Impact with standard mitigation |
| Only 1 NSR location where cumulative pre-construction works may result in impact which require enhanced mitigation (Threshold Category A (65) Exceeded at SSR4 using the Cable Route Option 1 and Option 2 only). | **>65 to 65.1** | Negligible Impact | Yes (Noise reduction of 0.1 required) | No Impact with enhanced mitigation |
| Duct Installation + Primary Works | **48.4 to 65** | No Impact | No | No Impact with standard mitigation |
| Only 1 NSR location where cumulative duct installation works may result in impact which requires enhanced mitigation (Threshold Category A (65) Exceeded at SSR4 using the Cable Route Option 1 and Option 2 only). | **>65 to 66.2** | Minor Impact | Yes (Noise reduction of1.2 required) | No Impact with enhanced mitigation |
| Cable Pull, joint and Commission | **36.3 to 65** | No Impact | No | No Impact with standard mitigation |
| **Required Mitigation Key** | | | | |
| No additional mitigation required beyond standard CoCP measures to avoid significant adverse impacts. | | | | |

| Phase | Predicted noise level $L_{Aeq, 12hr}$ dB (Standard mitigation applied) | Impact Magnitude (Standard mitigation only) | Required Enhanced Mitigation (Yes/No) and range dB(A) | Residual Impact Magnitude |
|---|---|---|---|---|
| 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. | | | | |

#### 25.9.1.2 Hornsea Project Three

273. There is the potential for construction traffic and phasing to lead to 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). As Hornsea Project Three is subject to EIA, it is anticipated that a construction noise and vibration assessment will be undertaken, in accordance with industry guidance, to specify best-practice mitigation to reduce the impacts at nearby receptors. It is also likely that mitigation measures will be specified to reduce construction noise and vibration impacts of Hornsea Project Three. It is therefore considered that, with the adoption of BPM, 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 Norfolk Boreas

274. There is potential for a cumulative impact associated with the operational phase to occur during operation of the Norfolk Vanguard onshore project substation in conjunction with Norfolk Boreas onshore project substation.

275. The magnitude of impacts has been assessed in accordance with BS 4142:2014 derived thresholds detailed within Table 25.20 and the significance criteria detailed in Table 25.28.

276. Table 25.42 contains a summary of the worst case potential operational noise impacts associated with the onshore project infrastructure at the agreed receptor locations. This noise modelling has been carried out to inform the development of the design of the Norfolk Vanguard and Norfolk Boreas onshore project substations. The results of the modelling will be used to assist in the design of the projects which employ suitable suites of mitigation measures to deliver the required noise reduction to ensure the final design of both projects operating together confidently meet the low noise emission requirements.

277. During consultation (at ETG meetings) with the Environmental Health Officer at Breckland Council, it was identified that there would be a requirement for noise emissions from the cumulative onshore substations to not exceed the permitted noise levels for the existing Necton (Dudgeon) substation, specifically:

- The noise rating level (defined as set out in BS4142) from the operation of the substations 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 substations shall not exceed a limit value of 32dB $L_{Leq\ (15\ minutes)}$ in the 100Hz third octave band, at any time at a free field location immediately adjacent to any noise sensitive location.

278. These limits as agreed would apply to Norfolk Vanguard and Norfolk Boreas cumulatively, and through using the 2017 baseline data to determine existing background and ambient soundscape conditions.

279. It is apparent from the data presented within Table 25.42 (that using the updated component data provided by the onshore project substation supply chain), Norfolk Vanguard onshore project substation and Norfolk Boreas cumulatively, without the application of additional noise mitigation measures will fall outside the 32dBZ(100hz) limit and result in at most a **moderate** impact at identified receptor locations in accordance with BS4142:2014 derived impact magnitudes. Therefore, using the significance matrix detailed in Table 25.28, at a medium sensitivity receptor, a **moderate adverse** impact is predicted.

**Table 25.42 Worst case cumulative operational noise impacts (without mitigation) – Norfolk Vanguard and Norfolk Boreas**

| 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) | 23.9 | 27.6 | 37.7 | 33.8 | No Impact | Yes |
| | FF (First Floor) | 25.2 | 27.4 | 37.7 | 33.8 | No Impact | Yes |
| SSR2 | GF | 31.4 | 33.8 | 32.2 | 28.4 | Minor | No |
| | FF | 33.4 | 34.3 | 32.2 | 28.4 | Minor | No |
| SSR3 | GF | 24.0 | 28.0 | 32.2 | 28.4 | No Impact | Yes |
| | FF | 25.5 | 28.3 | 32.2 | 28.4 | 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 | | |
| SSR4 | GF | 24.2 | 32.8 | 31.0 | 22.9 | Negligible | No |
| | FF | 25.1 | 33.1 | 31.0 | 22.9 | Negligible | No |
| SSR5 | GF | 25.7 | 29.0 | 50.5 | 29.9 | No Impact | Yes |
| | FF | 27.8 | 29.5 | 50.5 | 29.9 | No Impact | Yes |
| SSR6 | GF | 16.8 | 26.3 | 36.0 | 28.6 | No Impact | Yes |
| | FF | 17.9 | 26.4 | 36.0 | 28.6 | No Impact | Yes |
| SSR7 | GF | 26.6 | 32.4 | 46.3 | 39.4 | No Impact | No |
| | FF | 27.3 | 32.7 | 46.3 | 39.4 | No Impact | No |
| SSR8 | GF | 22.7 | 29.3 | 58.4 | 36.8 | No Impact | Yes |
| | FF | 23.7 | 29.5 | 58.4 | 36.8 | No Impact | Yes |
| SSR9 | GF | 17.7 | 26.8 | 36.5 | 32.2 | No Impact | Yes |
| | FF | 19.7 | 27.4 | 36.5 | 32.2 | No Impact | Yes |
| SSR10 | GF | 29.6 | 32.5 | 34.0 | 21.8 | Moderate | No |
| | FF | 30.5 | 32.6 | 34.0 | 21.8 | Moderate | No |
| SSR11 | GF | 26.4 | 29.2 | 56.5 | 31.3 | No Impact | Yes |
| | FF | 28.3 | 29.8 | 56.5 | 31.3 | No Impact | Yes |
| | | BS4142 Criteria Met or 32dBZ 100Hz Requirement Met | | | | | |
| | | BS4142 Criteria Exceeded or 32dBZ 100Hz Requirement Exceeded | | | | | |

#### *25.9.2.1.1 Mitigation*

280. As discussed in section 25.8.4.2, technical mitigation measures are routinely applied to substations to reduce the potential worst case noise emissions.

281. At this stage the assessment provides indicative information on the level of mitigation which would be required to be embedded into the design of the onshore project substations at the detailed design stage.

282. Noise modelling for the cumulative impact of both Norfolk Vanguard and Norfolk Boreas substations was conducted applying the same mitigation measures detailed in section 25.8.6.2 for the Norfolk Vanguard onshore project substation in isolation.

283. The results of the cumulative mitigated noise modelling (Norfolk Vanguard substation and Norfolk Boreas substation) are detailed in Table 25.43. With the application of additional noise mitigation measures predicted noise levels fall within the 32dBZ(100hz) limit and result in **no impact** at identified receptor locations in accordance with BS4142:2014 derived impact magnitudes. Therefore, using the significance matrix detailed in Table 25.28, at a medium sensitivity receptor, a **negligible** impact is predicted.

**Table 25.43 Mitigated cumulative operational noise impacts – Norfolk Vanguard and Norfolk Boreas**

| 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) | 33.8 | 25.2 | 37.7 | 33.8 | No Impact | Yes |
| | FF (First Floor) | 33.8 | 25.0 | 37.7 | 33.8 | No Impact | Yes |
| SSR2 | GF | 28.4 | 31.1 | 32.2 | 28.4 | No Impact | Yes |
| | FF | 28.4 | 31.5 | 32.2 | 28.4 | No Impact | Yes |
| SSR3 | GF | 28.4 | 25.4 | 32.2 | 28.4 | No Impact | Yes |
| | FF | 28.4 | 25.7 | 32.2 | 28.4 | No Impact | Yes |
| SSR4 | GF | 22.9 | 30.8 | 31.0 | 22.9 | No Impact | Yes |
| | FF | 22.9 | 31.0 | 31.0 | 22.9 | No Impact | Yes |
| SSR5 | GF | 29.9 | 26.5 | 50.5 | 29.9 | No Impact | Yes |
| | FF | 29.9 | 27.0 | 50.5 | 29.9 | No Impact | Yes |
| SSR6 | GF | 28.6 | 24.0 | 36.0 | 28.6 | No Impact | Yes |
| | FF | 28.6 | 24.1 | 36.0 | 28.6 | No Impact | Yes |
| SSR7 | GF | 39.4 | 31.1 | 46.3 | 39.4 | No Impact | Yes |
| | FF | 39.4 | 31.3 | 46.3 | 39.4 | No Impact | Yes |
| SSR8 | GF | 36.8 | 27.5 | 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 | 36.8 | 27.7 | 58.4 | 36.8 | No Impact | Yes |
| SSR9 | GF | 32.2 | 25.1 | 36.5 | 32.2 | No Impact | Yes |
| | FF | 32.2 | 25.4 | 36.5 | 32.2 | No Impact | Yes |
| SSR10 | GF | 21.8 | 29.9 | 34.0 | 21.8 | No Impact | Yes |
| | FF | 21.8 | 30.0 | 34.0 | 21.8 | No Impact | Yes |
| SSR11 | GF | 31.3 | 27.1 | 56.5 | 31.3 | No Impact | Yes |
| | FF | 31.3 | 27.7 | 56.5 | 31.3 | No Impact | Yes |
| | | BS4142 Criteria Met or 32dBZ 100Hz Requirement Met | | | | | |
| | | BS4142 Criteria Exceeded or 32dBZ 100Hz Requirement Exceeded | | | | | |

284. Table 25.43 shows that with the application of additional noise mitigation measures at the Norfolk Vanguard and Norfolk Boreas onshore substation infrastructure, predicted noise levels result in **no effect** at identified receptor locations. Therefore, using the significance matrix detailed in Table 25.28, at a medium sensitivity receptor, a **negligible** impact is predicted.

#### 25.9.2.2 Dudgeon Offshore Wind Farm

285. There is a potential for cumulative impact associated with the operational phase to occur during operation of the onshore project substation in conjunction with Norfolk Boreas and Dudgeon onshore project substations. Background noise values for the Norfolk Vanguard assessment and cumulative assessment were derived from noise monitoring conducted whilst the Dudgeon substation was not operating at full capacity. The resulting $L_{A90}$ values used in the assessment therefore provide a conservative baseline (on the premise that background noise levels will be lower) to inform the design of the onshore project substation and ensure the amenity of nearby residents.

286. Norfolk Vanguard onshore project substation detailed design would prevent significant impacts and ensure that residential amenity is protected from any adverse effects of noise. Commitments relating to operational noise are secured through DCO requirement 27. Suitable mitigation measures will deliver the required

noise reduction to ensure the final design of both projects operating together meet the low noise emission requirements set out by Breckland Council.

### 25.9.3 Cumulative Impacts during Decommissioning

287. Decommissioning of Norfolk Boreas and Hornsea Project Three may potentially take place at the same time as the Norfolk Vanguard project. The detail and scope of the decommissioning works for the Norfolk Vanguard project 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

288. Parameters or 'sources' that are considered to interact with receptors identified in this chapter are listed in Table 25.44.

**Table 25.44 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<br>Chapter 23 Onshore Ornithology<br>Chapter 24 Traffic and Transport<br>Chapter 27 Human Health<br>Chapter 28 Onshore Archaeology and Cultural Heritage<br>Chapter 30 Tourism and Recreation | Section 25.8.5.5 | There could be potential noise impacts related to construction traffic movements. |
| Operational noise impacts | Chapter 22 Onshore Ecology<br>Chapter 23 Onshore Ornithology<br>Chapter 24 Traffic and Transport<br>Chapter 27 Human Health<br>Chapter 28 Onshore Archaeology and Cultural Heritage<br>Chapter 30 Tourism | Section 25.8.6 | There could be potential impacts on onshore ecology and designated sites as a result of operational noise emissions from the onshore project substation. |

| Topic and description | Related Chapter | Where addressed in this chapter | Rationale |
|---|---|---|---|
| | and Recreation | | |

## 25.11 Interactions

289. 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 25.45, along with an indication as to whether the interaction may give rise to synergistic impacts.

**Table 25.45 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

290. This section summarises the main findings from the impact assessment based on the worst case assumptions. This is outlined in Table 25.46. For the assessed construction phases, impacts are predicted to range from **no impact** to **major**

**adverse**. However, with the adoption of CoCP (DCO requirement 20), enhanced mitigation measures and BPM, residual impacts are predicted to be no impact. Operational phase impacts were predicted to be **minor adverse** at assessed sensitive receptors without mitigation. With the incorporation of suitable mitigation (as detailed in Table 25.37), residual impacts are predicted to be **no impact** at identified receptors.

**Table 25.46 Potential impacts identified for noise and vibration**

| Potential Impact | Receptor | Value/ Sensitivity | Magnitude | Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| **Construction** | | | | | | |
| Landfall Daytime | Residential | Medium | No Impact | No Impact | CNMP | **No Impact** |
| Landfall Evening and weekends | Residential | Medium | No Impact | No Impact | CNMP | **No Impact** |
| Landfall night-time | Residential | Medium | Minor to Major Adverse | Minor Adverse to Major Adverse Impact | CNMP + Enhanced mitigation (localised screening and increased separation distances). | **No Impact** |
| Onshore cable route | Residential | Medium | No Impact to Major Adverse | No Impact to Major Adverse Impact | CNMP + Enhanced mitigation (localised screening and increased separation distances). | **No Impact** |
| Onshore project substation | Residential | Medium | No Impact to Minor (depending on export cable route option) | No Impact to Minor Adverse Impact (depending on export cable route option) | CNMP + Enhanced mitigation (localised screening and increased separation distances). | **No Impact** |
| Traffic | Residential | Medium | Moderate Adverse | Moderate Adverse Impact | TMP (refer to Chapter 24 Traffic and Transport) | **Minor Adverse** |
| Vibration | Residential | Medium | No impact | No impact | n/a | **No Impact** |

| Potential Impact | Receptor | Value/ Sensitivity | Magnitude | Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| **Operation** | | | | | | |
| Noise | Residential | Medium | Minor Adverse | Minor Adverse Impact | Designed to prevent significant adverse impacts, BAT. (see section 25.8.6.2). | **No Impact** |
| Vibration | Residential | Medium | No Impact | No Impact | n/a | **No Impact** |
| **Decommissioning** | | | | | | |
| Landfall Daytime | Residential | Medium | No Impact | No Impact | CNMP | **No Impact** |
| Onshore cable route | Residential | Medium | No Impact to Major Adverse | No Impact to Major Adverse Impact | CNMP + Enhanced mitigation (localised screening and increased separation distances). | **No Impact** |
| Onshore project substation | Residential | Medium | No Impact to Minor (depending on export cable route option) | No Impact to Minor Adverse Impact (depending on export cable route option) | CNMP + Enhanced mitigation (localised screening and increased separation distances). | **No Impact** |
| Traffic | Residential | Medium | Moderate Adverse | Moderate Adverse Impact | TMP (refer to Chapter 24 Traffic and Transport) | **Minor Adverse Impact** |
| Vibration | Residential | Medium | No Impact | No Impact | n/a | **No Impact** |
| **Cumulative** | | | | | | |
| Construction including National Grid extension | Residential | Medium | No Impact to Minor Impact (depending on export cable route option) | No Impact to Minor Adverse Impact (depending on export cable route option) | CNMP + Enhanced mitigation (localised screening and increased separation distances). | **No Impact** |

| Potential Impact | Receptor | Value/ Sensitivity | Magnitude | Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| **Cumulative** | | | | | | |
| Operation | Residential | Medium | Moderate Adverse | Moderate Adverse Impact | BAT | **No Impact** |
| **Cumulative during 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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