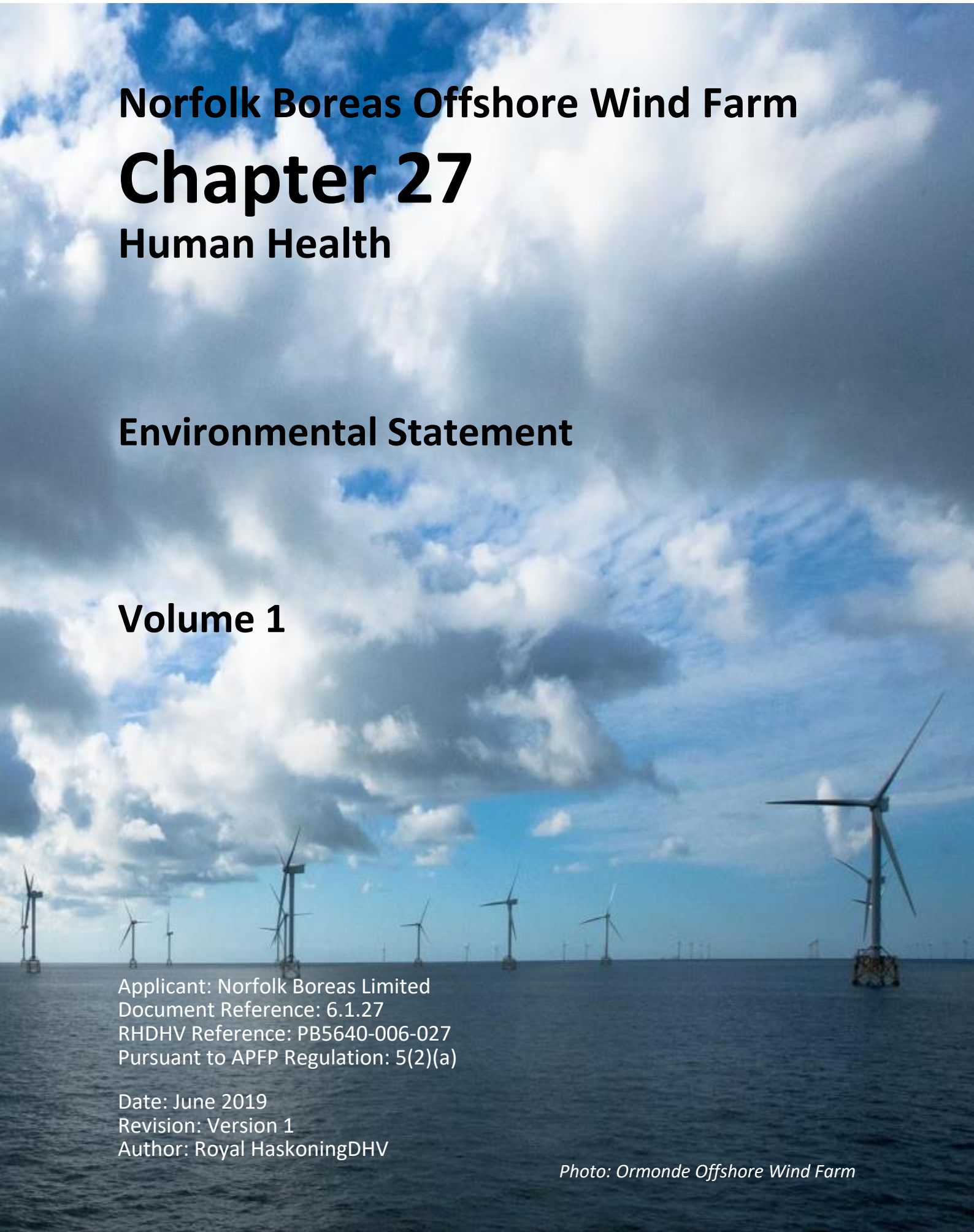
Norfolk Boreas Offshore Wind Farm

Chapter 27

Human Health

Environmental Statement

Volume 1



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Glossary of Acronyms

AHAH	Access to Health Assets and Hazards
ALARP	As Low As Reasonably Practicable
AQO	Air Quality Objective
CoCP	Code of Construction Practice
CTMP	Construction Traffic Management Plan
DCO	Development Consent Order
DECC	Department of Energy and Climate Change
EIA	Environmental Impact Assessment
ELF	Extremely Low Frequency
EMF	Electromagnetic field
ES	Environmental Statement
HDD	Horizontal Directional Drilling
HGV	Heavy Good Vehicle
HIA	Health Impact Assessment
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
JSNA	Joint Strategic Needs Assessment
ICNIRP	International Commission on Non-ionizing Radiation Protection
IEMA	Institute of Environmental Management and Assessment
IPC	Infrastructure Planning Commission
LEP	Local Enterprise Partnership
LSOA	Lower Super Output Area
NPS	National Policy Statement
NRPB	National Radiological Protection Board
ONS	Office of National Statistics
PEIR	Preliminary Environmental Information Report
PHE	Public Health England
PM	Particulate Matter
PRoW	Public Rights of Way
SAGE	Stakeholder Advisory Group on Extremely Low Frequency Electric and Magnetic Fields
UOESEA	UK Offshore Energy Strategic Environmental Assessment
VWPL	Vattenfall Wind Power Limited
WHO	World Health Organisation

Glossary of Terminology

Cable pulling	Installation of cables within pre-installed ducts from jointing pits located along the onshore cable route.
Ducts	A duct is a length of underground piping, which is used to house electrical and communications cables.
Evidence Plan Process	A voluntary consultation process with specialist stakeholders to agree the approach to the EIA and information to support the HRA.
Jointing pit	Underground structures constructed at regular intervals along the onshore cable route to join sections of cable and facilitate installation of the cables into the buried ducts.
Landfall	Where the offshore cables come ashore at Happisburgh South.
Landfall compound	Compound at landfall within which HDD drilling would take place.
Mobilisation area	Areas approx. 100 x 100m used as access points to the running track for duct installation. Required to store equipment and provide welfare facilities. Located adjacent to the onshore cable route, accessible from local highways network suitable for the delivery of heavy and oversized materials and equipment.
National Grid overhead line modifications	The works to be undertaken to complete the necessary modification to the existing 400kV overhead lines.
National Grid substation extension	The permanent footprint of the National Grid substation extension.
National Grid overhead line temporary works	Area within which the work will be undertaken to complete the necessary modification to the existing 400kV overhead lines.
National Grid substation extension	The permanent footprint of the National Grid substation extension.
National Grid temporary works area	Land adjacent to the Necton National Grid substation which would be temporarily required during construction of the National Grid substation extension.
Necton National Grid substation	The grid connection location for Norfolk Boreas and Norfolk Vanguard.
Onshore 400kV cable route	Buried high-voltage cables linking the onshore project substation to the Necton National Grid substation.
Onshore cable route	The up to 35m working width within a 45m wide corridor which will contain the buried export cables as well as the temporary running track, topsoil storage and excavated material during construction.
Onshore cables	The cables which take power and communications from landfall to the onshore project substation.
Onshore project area	The area of the onshore infrastructure (landfall, onshore cable route, accesses, trenchless crossing zones and mobilisation areas; onshore project substation and extension to the Necton National Grid substation and overhead line modifications).
Onshore project substation	A compound containing electrical equipment to enable connection to the National Grid. The substation will convert the exported power from HVDC to HVAC, to 400kV (grid voltage). This also contains equipment to help maintain stable grid voltage.
Running track	The track along the onshore cable route which the construction traffic would use to access workfronts.
The Applicant	Norfolk Boreas Limited
The project	Norfolk Boreas Wind Farm including the onshore and offshore infrastructure.
Trenchless crossing zone	Areas within the onshore cable route which will house trenchless crossing

(e.g. HDD)	entry and exit points.
Workfront	A length of onshore cable route within which duct installation works will occur, approximately 150m.

27 Human Health

27.1 Introduction

1. This chapter of the Environmental Statement (ES) considers the potential health effects associated with the Norfolk Boreas Offshore Wind Farm (herein referred to as 'the project').

2. This chapter meets the requirements of the Environmental Impact Assessment (EIA) Regulations 2017 in providing reasoned conclusions for the identification and assessment of any likely significant effects of the project on human health. This chapter follows best practice guidance (Cave *et al*., 2017a), in considering health effects with regard to the general population and vulnerable population groups. Populations are considered at both regional and local levels.

3. This chapter follows the World Health Organisation (WHO) definition of health as a state of physical, mental and social wellbeing, as well as the absence of disease or infirmity. Similarly, it also considers issues of wellbeing as a state in which every individual realises his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to their, her or his community.

4. The context of people's lives determines their health. Therefore, both the WHO and Public Health England (PHE) consider that health and wellbeing are influenced by a range of factors, termed the 'wider determinants of health'. Determinants include the social and economic environment, the physical environment, and individual characteristics or behaviours.

5. The focus of the chapter is on community health and wellbeing and not on occupational health and safety. The term 'health' is used to describe 'human health' and 'wellbeing' unless specifically referenced otherwise.

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

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

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

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

8. This chapter informs and has been informed by other relevant chapters of this ES. These include:

- Chapter 20 Water Resources and Flood Risk;
- Chapter 24 Traffic and Transport;
- Chapter 25 Noise and Vibration;
- Chapter 26 Air Quality;
- Chapter 29 Landscape and Visual Impact Assessment;
- Chapter 30 Tourism and Recreation;
- Chapter 31 Socio-economics; and
- Chapter 34 Onshore Cumulative Effects.

9. This chapter brings together the relevant information on health, including assessing the findings of other chapters within this ES in population health terms. This approach aims to assist in identifying project factors which may affect human health and wellbeing.

27.2 Legislation and Guidance

27.2.1 Legislation

10. The following legislative context has informed the assessment.

11. The Health and Safety at Work Act 1974 (HM Government of Great Britain, 1974) places duties on employers to ensure, so far as is reasonably practicable: the health, safety and welfare at work of all their employees; and that persons not in their employment are not exposed to risks to their health or safety as a result of the activities undertaken. In both cases, the requirement for risks to be reduced to As Low As Reasonably Practicable (ALARP) is fundamental and applies to all activities within the scope of the Health and Safety at Work Act 1974.

12. The Control of Major Accident Hazards Regulations 1999 relate to the management of threshold quantities of dangerous substances identified in the regulations (HM Government of Great Britain, 1999).

13. The Health Protection Regulations 2010 came into force to complete the modernised legal framework for health protection in England. Three sets of regulations complement the updated Public Health (Control of Disease) Act 1984, which was substantially amended by the Health and Social Care Act 2008. These are:

- The Health Protection (Notification) Regulations 2010 (SI 2010/659);

- The Health Protection (Local Authority Powers) Regulations 2010 (SI 2010/657); and
- The Health Protection (Part 2A Orders) Regulations 2010 (SI 2010/658).

14. The Clean Air Act (1993) aims to reduce pollution from smoke, grit and dust and gives local authorities powers to designate smoke control areas (HM Government of Great Britain & Northern Ireland, 1993). The Air Quality Standards Regulations 2010 transpose into English law the requirements of Directives 2008/50/EC and 2004/107/EC on ambient air quality.

15. Part III of the Environmental Protection Act 1990 discusses control of emissions (including dust, noise and light) that may be prejudicial to health or a nuisance (HM Government of Great Britain & Northern Ireland, 1990).

16. The International Convention for the Prevention of Pollution from Ships (MARPOL) includes regulations aimed at preventing and minimising, both accidental and operational, pollution from ships (International Maritime Organisation, 1973).

17. The revised Bathing Water Directive 2006/7/EC safeguards public health and clean bathing waters (European Parliament and Council of the European Union, 2006). Bathing waters are also protected under the Water Framework Directive 2000/60/EC (European Parliament and Council of the European Union, 2000).

27.2.2 Guidance

18. Planning Practice Guidance on Environmental Impact Assessment (EIA) explains the requirements of the Town and Country Planning (EIA) Regulations 2017. The guidance does not provide any additional information in relation to defining, scoping or assessing 'population and human health'. Regard has therefore been given to the advice provided in the Institute of Environmental Management and Assessment, 2017: Health in Environmental Assessment, a primer for a proportionate approach (Cave et al., 2017a). Public Health England has also issued a briefing note on health in EIA for local public health teams (Cave et al., 2017b).

19. The approach to assessing health in EIA has also been informed by relevant UK guidance on Health Impact Assessment (HIA). In England there is no overarching guidance for HIA. However, generic principles are evident in specialist guidance such as that by the Department of Health in relation to HIA of government policy (Department of Health, 2010), or that by the London Healthy Urban Development Unit in relation to urban planning (NHS Healthy Urban Development Unit, 2015). In Wales there is good quality project level guidance on HIA by the Wales Health Impact Assessment Support Unit (WHIASU, 2012). Similarly in Northern Ireland overarching project level HIA guidance is provided by the Institute of Public Health in Ireland (Metcalfe *et al,* 2009). HIA guidance from Scotland includes discussion of

issues relevant to rural contexts (Higgins *et al.,* 2015). The HIA guidance is used as useful contextual guidance in the production of this ES chapter which is intended to provide reasoned conclusions for the identification and assessment of any likely significant effects of the project on human health in compliance with the EIA Regulations 2017.

20. Guidance published by the World Bank Group (World Bank Group, 2015) advises that community health and safety hazards specific to wind energy include blade or ice throw, aviation impacts, marine navigation, electromagnetic fields, public access, and abnormal load transportation. Due to the project being located 72km from the coast (see Chapter 5 Project Description), blade or ice throw and aviation issues are unlikely to be a concern for local populations to the onshore cable route. Marine navigation is considered in Chapter 15 Shipping and Navigation.

21. Public Health England (PHE) released guidance in 2013 regarding the health effects of exposure to electric and magnetic fields; this guidance has been used to consider the effects of electromagnetic fields (EMF) in section 27.6 (PHE, 2013).

22. In March 2004, the National Radiological Protection Board (NRPB) (now part of PHE), published advice on limiting public exposure to electromagnetic fields. The advice was based on an extensive review of the science and a public consultation on its website, and recommended the adoption in the UK of the EMF exposure guidelines published by the International Commission on Non-ionizing Radiation Protection (ICNIRP). The ICNIRP guidelines are based on the avoidance of known adverse effects of exposure to EMF at frequencies up to 300 GHz (gigahertz), which includes static magnetic fields and 50 Hz electric and magnetic fields associated with electricity transmission (McKinlay *et al*., 2004).

23. This human health chapter has had regard to the precautionary findings of the UK Stakeholder Advisory Group on Extremely Low Frequency Electric and Magnetic Fields (SAGE). SAGE was initiated by National Grid and was adopted by the Department of Health in order to provide advice to the Government (Stakeholder Advisory Group on Extremely Low Frequency (ELF) EMFs, 2010).

27.3 Methods

27.3.1 General Approach

24. This section sets out the methods for providing reasoned conclusions for the identification and assessment of any likely significant effects of the project on human health (as required by the EIA Regulations 2017).

25. Consistent with the objective of EIA (as set out in EIA Directive 2014/52/EC), the methods identify effects that provide, or are contrary to providing, a high level of

protection to human health. This includes reasoned conclusions in relation to health protection, health improvement and/or improving services.

26. The methods provide a framework to identify (at both scoping and assessment):

- The 'likelihood' of the project having an effect on health; and
- If an effect is likely, whether it may be 'significant' in the terms of the EIA Regulations.

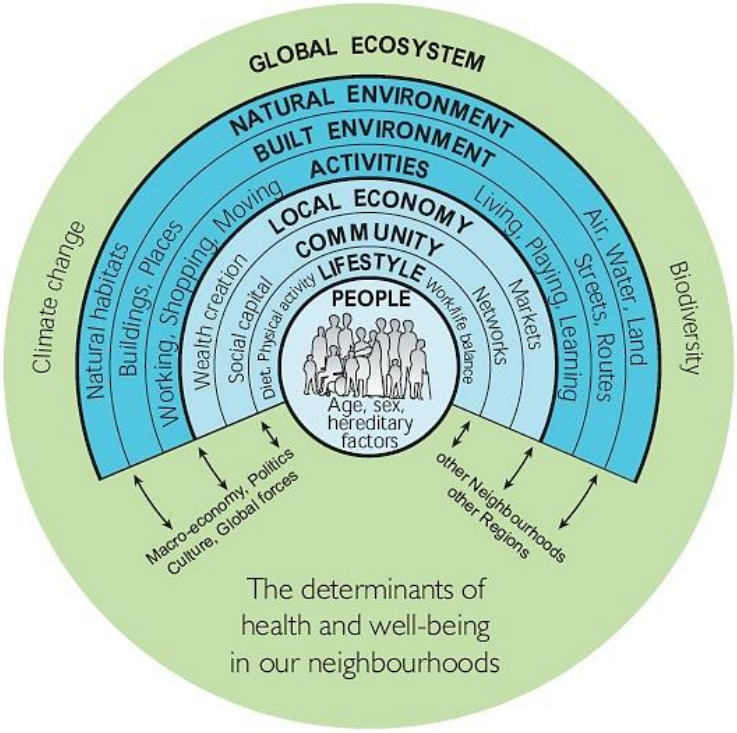
27. Effects are considered with regard to the general population and vulnerable groups. Populations are considered at regional and local levels.

28. In line with best practice guidance from PHE (PHE, 2017c), "health determinants" are considered to understand effects of human health and wellbeing. The methodology uses emerging best practice published by the Institute of Environmental Management and Assessment (IEMA) in line with the 'Health in Environmental Impact Assessment: A Primer for a Proportionate Approach' (Cave *et al*., 2017a).

27.3.2 Health Determinants

29. Human health can be influenced by a wide variety of direct and indirect factors, from controllable factors such as lifestyle to uncontrollable factors such as genetics. The influences and effects can be wide-ranging and are likely to vary between individuals. In determining 'physical, mental and social wellbeing', external contributory factors, known as 'determinants', are considered. Determinants are a reflection of a mix of influences from an individual's society and environment.

30. The 'wider determinants of health' model is used to conceptualise how human health spans environmental, social and economic aspects. This is illustrated in Plate 27.1



Source: Based on the Dahlgren and Whitehead (1991) diagram as amended by Barton and Grant (2006) and advised by Cave *et al*. (2017)

Plate 27.1 Wider determinants of public health

31. Influences that result in a change in determinants have the potential to cause beneficial or adverse effects on health, either directly or indirectly. The degree to which these determinants influence health varies, given the degree of personal choice, location, mobility, and exposure.

27.3.3 Likelihood

32. The first issue to consider in scoping or assessment is the likelihood of the project having an effect. A likely effect should be both plausible and probable.

- Plausible relates to their being a relevant source, pathway and receptor (see discussion of health pathways below).
- Probable relates to a qualitative judgement to exclude those effects that could only occur under certain very rare conditions, except where these relate to the projects vulnerability to major accidents or disasters (as required by Part 1 paragraph 4(4) EIA Regulation 2017).[1]

33. The term 'health pathways' describe how a specific activity of the project could change a determinant of health and potentially result in a change in health

[1] Chapter 5 Project Description includes a section on Major Accidents and Disasters. This finds that there are no causal pathways between the project and major accidents.

outcomes (an effect). Health pathways are considered with regard to the source, pathway, and impact as follows:

- A 'source' represents an activity or factor that could affect the health outcomes of a receptor population.
- A 'pathway' describes the method or route by which the 'source' could affect the 'receptor' (either causation or association).
- A 'receptor' is the recipient of an effect from the 'source', via the 'pathway'.

34. Table 27.1 shows how the Source-Pathway-Receptor model can be used to identify plausible health effects. Only plausible health effects are considered within the assessment.

Table 27.1 Use of a Source-Pathway-Receptor model to identify plausible health effects

Source	Pathway	Receptor	Plausible health effect?	Rationale
×	✓	✓	No	There is not a clear source from where a potential health effect could originate.
✓	×	✓	No	The source of a potential health effect lacks a means of transmission to a population.
✓	✓	×	No	Receptors that would be sensitive and vulnerable to the health effect are not present.
✓	✓	✓	Yes	Identifying a source, pathway and receptor does not mean an effect is a likely significant effect; the probability of the effect should be qualitatively considered and a professional judgement reached on the significance of effects that are considered likely.

27.3.4 Significance

35. A determination of significance is required for compliance with the EIA regulations 2017 when a potential effect of the project is likely (or relates to the project's vulnerability to major accidents or disasters).

36. The determination of significance has two stages:

- Firstly, the sensitivity of the receptor affected, and the magnitude of the plausible health effect upon it are characterised. This establishes whether there is a relevant population and a relevant change in health outcomes to consider.
- Secondly, a professional judgement is made as to whether or not the change in a population's health is significant. This judgement is based on the collection and presentation of data to evidence reasoned conclusions.

27.3.4.1 Sensitivity

37. Table 27.2 sets out factors characterising sensitivity for human health. The table informs the professional judgement on scoring high, medium, low or negligible sensitivity. In line with best practice a formulaic matrix approach to determining sensitivity has been avoided. The 'higher' and 'lower' sensitivity characterisations represent instructive positions on a spectrum that would also include more extreme, as well as intermediate, positions. Most situations have a mix of higher and lower characterising factors so a balanced expert view of sensitivity is taken.

Table 27.2 Factors Characterising Population Sensitivity (Cave et al., 2017a)

	Inequalities	Deprivation	Health status	Life stage	Outlook
Higher sensitivity	High levels of inequalities or inequities.	High levels of overall deprivation or a high level of deprivation for a relevant sub-domain of the indices of multiple deprivation. High levels of poor access to financial, social or political resources.	High levels of poor health and/or disability (particularly multiple or complex long-term health conditions). High reliance on (or low capacity in) healthcare facilities, staff or resources.	Presence of dependants (particularly the elderly or children), pregnant women, shift workers or the economically inactive.	Presence of groups with strong views or high degrees of uncertainty about the project who may anticipate risks to their health and thus be affected by not only actual changes, but also by the possibility of change.
Lower sensitivity	Low levels of inequalities or inequities.	Low levels of overall deprivation or a low level of deprivation for a relevant sub-domain of the indices of multiple deprivation. Good access to financial, social or political resources.	Low levels of poor health and/or low levels of disability. Low reliance on (or high capacity in) healthcare facilities, staff or resources.	Predominantly a working age population in steady good quality employment.	No indication that strong views are held about the project. People are well informed of the issues and potential effects.

38. The assessment characterises the relevant populations for each health issue. For each category, the text sets out detail on the one or more relevant factors from Table 27.2 that informed the score.

27.3.4.2 Magnitude

39. Table 27.3 sets out factors characterising magnitude for human health. The table informs the professional judgement on assigning scoring of large, medium, small or negligible magnitude. In line with best practice for the assessment of human health,

a formulaic matrix approach to determining magnitude has not been used and instead this assessment relies upon specific factors that relate directly to population groups as demonstrated in Table 27.3. The 'larger' and 'smaller' magnitude characterisations represent instructive positions on a spectrum that would also include more extreme, as well as intermediate, positions.

Table 27.3 Factors Characterising Magnitude (Cave et al., 2017a)

	Severity	Extent	Frequency	Reversibility	Exposure
Larger magnitude	Large change in the risk of developing a new health condition (or injury) or in the progression of an existing condition. Large change in symptoms, quality of life or day-to-day functioning. Large change in inequalities.	Most members of the relevant population affected or vulnerable. Substantial population displacement or influx.	Continuous or daily effects with chronic (long term) changes in health outcomes.	Permanent change in health outcomes once the project change ceases. Intergenerational effects.	A low (or high) concentration over a long time, or a high concentration over a short time. Low (or high) exposure to a large population or high exposure to a small population. A high degree of resource sharing with the project.
Smaller magnitude	Small change in the risk of developing a new health condition (or injury) or in the progression of an existing condition. Small change in symptoms, quality of life or day-to-day functioning. Small change in inequalities.	Few members of the relevant population. Little change in population.	Monthly or yearly affects with acute (short term) changes in health outcomes.	Change in health outcomes reverses once the project change ceases. No intergenerational effects.	A low concentration over a short time. Low exposure to a small population. A low degree of resource sharing with the project.

40. The assessment characterises the relevant changes in health outcomes for each health issue. For each professional judgement on magnitude, the text sets out detail on the one or more relevant factors from Table 27.3 that informed the score.

27.3.4.3 Judgement framework for significance

41. Having established that a source, pathway and receptor for a plausible health effect exist, the magnitude/sensitivity methods are used to consider whether there is a relevant population to consider and a relevant change in health outcomes, a professional judgement is made as to whether or not the change in a population's health is significant.

42. The characterisation of sensitivity and magnitude provides consistency between EIA topics. However, other relevant information sources (in addition to sensitivity and magnitude) also need to be evidenced for the professional judgement on significance to be a reasoned and robust conclusion on population health outcomes.

43. The approach uses a framework for reporting on a range of data sources to ensure reasoned and robust professional judgements are reached. Key sources of data include: scientific literature; baseline conditions; health priorities; consultation responses; regulatory standards; and policy context.

44. Guide questions set out in Table 27.4 are used to inform the professional judgements on significance. The table informs the professional judgement on scoring Major, Moderate, Minor or Negligible significance. In line with best practice a formulaic matrix approach to determining significance has been avoided.

Table 27.4 Human health guide questions for determining significance (Cave et al., 2017a)

Evidence sources	Guide questions
Scientific literature	Is there a sufficient strength of evidence from sufficiently high quality studies to support an association between the project change, a relevant determinant of health and a relevant health outcome? Does the literature indicate thresholds or conditions for effects to occur? Are particular population groups identified as being particularly susceptible?
Baseline conditions	Are relevant sensitivities or inequalities identified in the scientific literature present? Does the baseline indicate that conditions differ from relevant local, regional or national comparators? Are their geographic or population features of the baseline that indicate effects could be amplified?
Health priorities	Have local, regional or national health priorities been set for the relevant determinant of health or health outcome (e.g. in Joint Strategic Needs Assessments or in Health and Wellbeing Strategies)?
Consultation responses	Has a theme of local, regional or national consultation responses related to the relevant determinant of health or health outcome?
Regulatory standards (if appropriate)	Is the change one that would be formally monitored by regulators? Are there regulatory or statutory limit values set for the relevant context? Has EIA modelling predicted change that exceed thresholds from the scientific literature or set by regulators? Are there relevant international advisory guideline limit values (e.g. by the World Health Organisation)?
Policy context	Does local, regional or national government policy raise particular expectations for the relevant project change, determinant of health or health outcome (e.g. levels should be as low as reasonably practicable)? Is there a relevant international policy context (e.g. treaties or conventions)?

45. The text of the assessment section provides a structured discussion that responds to each of these questions for each health issue. The discussion provides reasoned conclusions for the professional judgement as to whether in EIA terms an issue is significant, or not. Where appropriate, variation expressed in each evidence source has been reported. This approach is considered proportionate and in line with best practice for the consideration of human health in EIA.

46. Ultimately for human health, a likely significant health effect is one that should be brought to the attention of the determining authority, as the effect of the project is judged to provide, or be contrary to providing, a high level of protection to human

health. This may include reasoned conclusions in relation to health protection, health improvement and/or improving services.

47. For the purposes of the EIA, **major** and **moderate** effects are considered to be significant. In addition, whilst **minor** effects are not significant in their own right, it is important to distinguish these from other non-significant effects as they may contribute to significant cumulative effects.

48. Where significant adverse effects are identified, mitigation has been considered to reduce the significance of such effects. Similarly, enhancements have been considered where significant and proportionate opportunities to benefit population health have been identified. The residual effects represent the output of iterative assessment, taking into consideration the mitigation and enhancement measures.

49. The health chapter takes as its starting point the residual effects as assessed and determined in other relevant EIA topic chapters. This includes taking into account relevant embedded and standard good practice mitigation.

27.3.4.4 Population conclusions

50. A population health approach has been used, as it would be disproportionate to reach conclusions on the potential health outcomes of individuals. To take account of potential inequalities, where appropriate, conclusions on a particular health issue have been reached for more than one population. For example:

- One conclusion for the general population (for a defined area); and
- A second separate sub-population conclusion for relevant vulnerable groups (as a single defined class of sensitivities for that issue).

27.3.5 Cumulative Impact Assessment

51. The Human Health chapter takes a different approach to the methodology used for the Cumulative Impact Assessment (CIA) described in Chapter 6 EIA Methodology.

52. The cumulative assessment considers the inter-relationships between health effects both from within the project and in combination with effects from other projects. These are considered for:

- Project geographies:
  - Landfall;
  - Cable route;
  - Onshore project substation;
  - National Grid substation extension and overhead line modifications;
  - Locally, regional, and nationally.

- For the following vulnerable populations:
  - Children and young people;
  - Older people;
  - People with existing poor health; and
  - People living in deprivation.

53. Firstly the intra-project cumulative effects are considered. The aim of this step is to understand if different effects on health determinants from the project would cumulatively create a larger health effect, an additive effect. For example, at a section of the project would changes to noise levels, traffic density, and air quality combine to provide a more significant effect than as individual impacts.

54. Secondly the inter-project cumulative effects are considered. As with other chapters, projects are screened for assessment based on a list agreed with Norfolk County Council. Then projects are considered for cumulative effect at different locations and for different vulnerable populations.

27.4 Scope

27.4.1 Spatial scope

27.4.1.1 Study Areas

55. The project makes landfall at Happisburgh South, which is within the North Norfolk District. The onshore cable route travels inland towards Necton, through the Broadland and Breckland Districts of Norfolk County.

56. The following geographic area classifications have been used:

- Site-specific;
- Local (North Norfolk, Broadland and Breckland Districts);
- Regional (Norfolk County);
- National (England); and
- International.

57. The 'site specific' level considers localised effects with reference to routine statistics collected for Lower Super Output Areas (LSOAs), see section 27.5.3 on baseline. Specific consideration is given to the following three most representative LSOAs:

- North Norfolk 012A (representative of the population at landfall);
- Breckland 004C (representative of the onshore cable route population[2]); and

[2] Breckland 004C has been selected as a representative LSOA to characterise the population along the onshore cable route. Across the indices of multiple deprivation Breckland 004C is typically more deprived than other LSOAs along the onshore cable route (Department for Communities and Local Government, 2015).

- Breckland 004A (representative of the population at the onshore project substation and the National Grid substation extension and overhead line modifications).

58. The onshore cable route through Breckland 004C includes trenched and trenchless crossings, mobilisation areas and a representative spread of dwellings. The LSOAs selected are not intended to indicate the area of effect, but rather the profile of the affected population. It is considered disproportionate to the assessment to include all LSOAs along the cable route. Using Breckland 004C to characterise the population along the cable route is consistent with proportionately assessing the worst case.

59. Within the study areas the assessment defines ten population groups (described below). Defining these population groups allows a structured and consistent discussion in both the assessment and the cumulative assessment. Six of these population groups are geographically defined, the remaining four are defined in relation to reasons that a population may be sensitive, other than due to proximity.

60. The study areas used in other chapters of this ES are of relevance, but do not necessarily define the boundaries of potential health effects. For example effects on mental health and wellbeing are subjective and may not be limited to the area defined in relation to achieving certain regulatory thresholds. Consequently, this health chapter uses study areas to broadly define representative population groups rather than to set boundaries on the extent of potential effects.

27.4.1.2 Geographic Population Groups

61. Six population groups have been selected based on the geographic study areas:

- The population near landfall (site-specific);
- The population along the cable route (site-specific);
- The population near the onshore project substation and National Grid substation extension (site-specific);
- The population of North Norfolk, Broadland and Breckland districts (local);
- The population of Norfolk county (regional); and
- The population of England and beyond the borders of England (national and international).

27.4.1.3 Potentially Vulnerable Groups

62. In addition, four further population groups are defined in relation to their potential sensitivity to changes associated with the project (beneficial or adverse):

- Children and young people;
- Older people;
- People with existing poor health (physical and mental health); and
- People living in deprivation, including those on low incomes.

63. These groups are intentionally broadly defined to facilitate a consistent discussion across health issues and as a basis to considering cumulative effects. The impact assessment (section 27.6) discusses detail relevant to particular health issues. People falling into more than one group may be especially sensitive.

27.4.1.4 Temporal Scope

64. The temporal scope has been defined as follows:

- 'Very short term' relates to effects measured in hours, days or weeks (e.g. effects, associated with duct installation or cable pulling activity near a particular dwelling);
- 'Short term' relates to effects measured in months (e.g. requirements of the overall construction stage, such as workforce use of accommodation);
- 'Medium term' relates to effects measured in years (e.g. local employment during construction);
- 'Long term' relates to effects measured in decades (e.g. the operational stage).

27.4.2 Topic Scope

65. The scope of issues considered by this health chapter was informed by the project Scoping Report (Royal HaskoningDHV, May 2017), the Planning Inspectorate Scoping Opinion (The Planning Inspectorate, June 2017), and was developed in response to the EIA Regulations 2017. The approach to the assessment has since been acknowledged and agreed upon by PHE (section 27.5.4).

66. The scope of the health chapter focuses on the onshore infrastructure associated with the project. Following the principles outlined in section 27.3.3 (factors relating to likelihood) and section 27.3.4 (factors relating to significance) the following potential effects have been scoped out:

- Potential Offshore Health Effects Scoped Out
    - PHE note that operational wind farms should not produce emissions, pollutants, or waste products;
    - Landscape and visual impacts due to offshore wind turbines that are beyond the 35km limit of visual significance identified in Department of Trade and Industry (DTI) guidance;
    - The potential for the offshore wind farm, or its support vessels, to pose a hazard to shipping and/or aviation are not expected to have significant appreciable or significant effects on human health;
    - The presence of cable laying and support vessels close to the shore due to temporary nature of such activities;
    - The potential for bathing waters to be affected by sedimentation and/or fuel spills associated with the horizontal drilling of the cable route at the

landfall due to the small quantities of sediment and low probability of occurrence; and
    - Effects due to the subsequent development of port facilities because this will be considered under a separate application.

- Potential Onshore Health Effects Scoped Out:
    - Health effects arising from the manufacturing plants. Due to the manufacturing requirements of the offshore elements for Norfolk Boreas; the supply chain for the project has not yet been developed at this point and therefore the health effects arising cannot be determined. However, these would be subject to relevant health assessments by the manufacturers;
    - The potential for negative health or social effects due to the workforce because:
        i. workers are likely to be UK based;
        ii. workers will be of working age and of good health;
        iii. in-migrant workers would be distributed across Norfolk and Suffolk in existing rental accommodation (such as hotels); and
        iv. it is expected that migrant workers are likely to return to their homes over the weekend;
        v. effects on local services because resident workers would continue to use their own registered GP and
        vi. a high standard of workforce conduct is mandated by the VWPL (parent company of Norfolk Boreas Limited) code of conduct[3] both at work and when staying in host communities.

27.4.2.1 Potential onshore health effects scoped in

67. This section outlines the topic scope for health issues that have been assessed in this chapter due to the potential for likely significant effects to human health. These effects will also be considered cumulatively within the project and with other projects (section 27.7).

68. The chapter assesses the potential for likely significant health effects to occur during construction, operation and decommissioning as described in Table 27.5.

[3]Norfolk Boreas Limited is a company owned by Vattenfall Wind Power Limited (VWPL) and operating under VWPL's code of conduct, this is available on VWPL's corporate website at: https://corporate.vattenfall.com/globalassets/corporate/about_vattenfall/corporate_governance/doc/code_of_conduct_2014.pdf

Table 27.5 Potential sources of impact leading to potential health effects

Potential Source	Potential pathway	Potential Receptor	Relevant ES chapter
Construction			
Noise from excavation machinery and associated movements	Temporary nuisance	Site specific populations or any sensitive groups such as schools or residential homes	Chapter 25 Noise and Vibration
Dust generated during construction	Temporary nuisance or inhalation of particulates	Site specific populations	Chapter 26 Air Quality
Exhaust emissions and particulates from machinery		Site specific populations and localised populations within Norfolk County	
Accidental spillage	Emissions to ground or surface water	Site specific populations	Chapter 19 Ground Conditions and Contamination Chapter 20 Water Resources and Flood Risk
Temporary disturbance or obstruction of roads and footpaths due to road transportation of materials and equipment, workforce traffic, and construction areas	Loss of access to green space or diversions to access routes	Site specific populations and localised populations within Norfolk County	Chapter 30 Tourism and Recreation
	Disruption of access to services and amenities	Site specific populations and localised populations within Norfolk County	Chapter 24 Traffic and Transport
Construction and operation			
Increases in employment and commercial opportunity	Increased wealth in populations	Population of New Anglia Local Enterprise Partnership (LEP)	Chapter 31 Socio-economics
Operation			
Noise from the onshore project substation	Long term nuisance	Site specific population at the onshore project substation	Chapter 25 Noise and Vibration
Electromagnetic Fields from the underground cables, onshore project substation, and National Grid Substation Extension[45]	Interaction with magnetic fields	Site specific population along the cable route and at the onshore project substation.	Since these documents were produced, the Applicant has subsequently committed to high voltage direct current (HVDC) technology. As such only the analysis of potential HVDC EMF levels contained within those documents is relevant to this application.

[4] For information on Norfolk Boreas EMF - https://corporate.vattenfall.co.uk/contentassets/bf0e5e31bbab467eaf02040c7b17513a/vattenfall-emf-information-sheet.pdf

[5] For information on Norfolk Boreas and Hornsea Project 3 cable route crossing - https://corporate.vattenfall.co.uk/contentassets/bf0e5e31bbab467eaf02040c7b17513a/vattenfall-orsted-emf-information-sheet.pdf

27.4.2.2 Scenarios

69. As outlined in section 27.1, Norfolk Boreas is the sister project to Norfolk Vanguard. VWPL is developing the two projects in tandem, and is planning to co-locate the export infrastructure for both projects in order to minimise overall impacts. This strategy applies to both the offshore and onshore elements of the cable route, landfall, and onshore project substations.

70. Whilst it is anticipated that Norfolk Vanguard will proceed to construction, to be a stand-alone project Norfolk Boreas needs to consider the possibility that Norfolk Vanguard may not proceed. In order for Norfolk Boreas to stand up as an independent project, this scenario must be provided for within the DCO application. Therefore, the following alternative scenarios have been considered within the EIA;

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

71. Please see chapter 5 Project Description for further details on the two scenarios.

72. Each potential effect will be considered with regard to Scenario 1 and Scenario 2 for each of the construction, operation, decommissioning phases, and cumulative impact.

73. Table 27.6 outlines the topic scope with respect to the identified spatial scopes (section 27.4.1) considered for human health under each scenario.

Table 27.6 Effect of scenarios on topic scope

Scope	Scenario 1	Scenario 2
Study Areas	Norfolk Vanguard would install the ducts for Norfolk Boreas. Therefore, effects at landfall, the onshore project substation area and cable pulling along the cable route is considered.	All aspects of onshore construction will be considered.
Geographic Population Groups	Site specific populations at landfall and onshore project substation areas are more likely to be affected. Local and regional populations are unaffected.	All site specific populations as well as local and regional populations.
Potentially Vulnerable Groups	Vulnerable groups are defined by the health determinant that is affected rather than the geographic context therefore these are consistent across scenarios.	
Temporal Scope	Only the additional aspects required for the Norfolk Boreas project will be assessed.	All aspects of onshore infrastructure necessary for an independent project will be assessed.
Cumulative impacts	The cumulative effects of both the Norfolk Boreas project and the preceding Norfolk Vanguard project will be considered.	No cumulative effects with Norfolk Vanguard would occur because Norfolk Vanguard would not have proceeded to construction.

27.5 Data Sources

27.5.1 Types of Data and Evidence

74. Data sources relating to human health receptors are presented in the following chapters:

- Chapter 20 Water Resources and Flood Risk;
- Chapter 24 Traffic and Transport;
- Chapter 25 Noise and Vibration;
- Chapter 26 Air Quality;
- Chapter 30 Tourism and Recreation; and
- Chapter 31 Socio-economics.

75. This health chapter is also informed by the following evidence sources, relevant data for which is summarised in the sections below:

- Scientific literature;
- Baseline conditions;
- Health priorities;
- Project-specific consultation responses; and
- Policy context.

76. The review of evidence sources has been structured using the following seven themes that cut across the scope of construction, operational and decommissioning effects of the project.

- Noise;
- Air quality;
- Ground and/or water contamination;
- Physical activity;
- Journey times and/or reduced access;
- Employment; and
- EMF.

27.5.2 Scientific Literature

77. An evidence base of publicly available information has been used to support the scoping and assessment conclusions of this health chapter. Evidence statements have been extracted from a review of abstracts and full articles published in English on PubMed from the past five years. The review is not exhaustive and aims to provide a summary only of the key issues relevant to the scope of this chapter. This is provided in Appendix 27.1.

27.5.3 Baseline Conditions

78. Health Profiles (PHE, 2017a), Health Assets Profiles (PHE, 2017b) from PHE and Wider Determinants of Health (PHE, 2017c) from PHE have informed the local, regional and national baseline for this health chapter; these 2017 publications are the most recent editions.

79. Office of National Statistics (ONS) and Nomis official labour market statistics (Nomis, 2017) have also informed the baseline (see Appendix 27.1). Whilst more recent statistics have been collected for some socio-economic variables, the 2011 census is considered an appropriate baseline for use in this chapter as it provides consistent comparative data across the population groups used in the assessment.

80. The Index of Multiple Deprivation 2015 has been consulted and referenced as appropriate, including sub-domains and underlying indicators (Department of Communities and Local Government, 2015); the 2015 Index is the most recent information available.

27.5.3.1 General

81. The onshore areas associated with the landfall and onshore cable route are predominantly rural in nature typified by small villages and hamlets and individual residential properties. The onshore project substation is located near the village of Necton to the west of the town of Dereham. This is also rural in nature with the village of Necton containing the largest concentration of residential properties.

82. The population within these areas has demonstrated moderate population growth, with the projected growth to 2025 similar to the UK national average projected between mid-2016 and mid-2026 (6.4%) (ONS 2017).

83. All areas considered above have a higher proportion of retirement-aged people in relation to their working age populations when compared with the national UK averages.

84. Much of the onshore infrastructure is largely routed through agricultural land. The onshore cable route passes close to built-up areas at North Walsham, as well as passing some individual properties.

85. Individual receptors that are sensitive to potential health effects from the construction phase have been discussed in the other ES chapters (such as noise and air quality). Sensitive receptors are typically associated with fixed infrastructure such as residential properties, schools, hospitals, footpaths, cycleways etc. This health chapter considers population group effects, rather than individual receptors.

86. The following baselines are summarised from the information in Appendix 27.1. This has three tables, Table 3.1, Table 3.2 and Table 3.3 that set out baseline data for site

specific, local, regional and national population groups. The data covers a range of variables relevant to the scope of this chapter. Appendix 27.1 also includes a discussion of data under the eight themes that cut across the scope of construction and operational effects of the project.

27.5.3.1.1 Norfolk County

87. The health of people in Norfolk is varied compared with the England average (Table 27.7). Health priorities for Norfolk County Council are the social and emotional wellbeing of children aged 0-5, obesity, and dementia.

Table 27.7 Health of people in Norfolk County (Source: Public Health England, 2017)

Factor	Norfolk County compared with England averages
Health of children	
Children living in low income families	18% (25,000). Lower than for England (20%)
Child obesity in Year 6 of school	18% (1,427) of children. Higher than the average for England (34%)
Alcohol specific hospital stays among those under 18	26 per 100,000 population. This represents 43 stays per year. Higher than the average for England
GCSE attainment	Lower than the England average
Smokers as a proportion of the population	Lower than the England average
Levels of breastfeeding initiation	Higher than the England average
Health of adults	
Life expectancy for women	83.6 in Norfolk compared to 82.9 in England
Life expectancy for men	80.2 in Norfolk compared to 79.2 in England
Life expectancy in the most deprived areas	Life expectancy is 6.3 years lower for men and 4.2 years lower for women
Rate of alcohol-related harm hospital stays	676 per 100,000 population. This represents 6,134 stays per year. Lower than the England average
Rate of self-harm hospital stays	225 per 100,000 population. Lower than the England average
Rate of smoking related deaths	247 per 100,000 population. This represents 1,527 deaths per year in the County. Higher than the England average
Estimated levels of adult excess weight	Lower than the England average
Estimated levels of adult smoking	Higher than the England average
The rate of people killed and seriously injured on roads	Lower than the England average
Rates of sexually transmitted infections and TB	Higher than the England average
Rate of statutory homelessness	Lower than the England average
Rate of violent crime	Higher than the England average
Rates of long term unemployment	Higher than the England average
Rate of early deaths from cardiovascular diseases	Higher than the England average
Rate of early deaths from cancer	Better than the England average

27.5.3.1.2 North Norfolk District

88. The health of people in North Norfolk is varied compared with the England average as shown in Table 27.8.

Table 27.8 Health of people in North Norfolk (Source: Public Health England, 2017)

Factor	North Norfolk District compared with England averages
Health of children	
Children live in low income families	17% (2,300). Lower than for England
Child obesity in Year 6 of school	17.0% (137). Higher than the average for England
Alcohol specific hospital stays among those under 18	18 per 100,000 population. This represents 3 stays per year
GCSE attainment	14 to 16%. Higher than the average for England
Levels of breastfeeding initiation	Higher than the England average
Health of adults	
Life expectancy for women	Higher than the England average
Life expectancy for men	Higher than the England average
Life expectancy in the most deprived areas	2.9 years lower for men in the most deprived areas
Rate of alcohol-related harm hospital stays	703 per 100,000 population. This represents 826 stays per year.
Rate of self-harm hospital stays	221 per 100,000 population. This represents 182 stays per year
Estimated levels of adult excess weight	Lower than the England average
Estimated levels of adult smoking	Higher than the England average
The rate of people killed and seriously injured on roads	Similar to England average
Rates of sexually transmitted infections and TB	Higher than the England average
Rate of violent crime	Higher than the England average
Rates of long term unemployment	Higher than the England average
Rate of early deaths from cardiovascular diseases	Higher than the England average
Rate of early deaths from cancer	Higher than the England average

27.5.3.1.3 Broadland District

89. The health of people in Broadland is variable when compared with the England average (Table 27.9). Broadland is one of the 20% least deprived districts/unitary authorities in England.

Table 27.9 Health of people in Broadland (Source: Public Health England, 2017)

Factor	Broadland District compared with England averages
Health of children	
Children live in low income families	10% (2,000). Lower than for England
Child obesity in Year 6 of school	13.4% (160). Higher than the average for England
Alcohol specific hospital stays among those under 18	33 per 100,000 population. This represents 8 stays per year
GCSE attainment	Higher than the England average
Levels of breastfeeding initiation	Higher than the England average
Health of adults	
Life expectancy for women	Higher than the England average
Life expectancy for men	Higher than the England average
Life expectancy in the most deprived areas than the least deprived areas	3.4 years lower for men and 4.2 years lower for women

Factor	Broadland District compared with England averages
Rate of alcohol-related harm hospital stays	588 per 100,000 population. This represents 797 stays per year.
Rate of self-harm hospital stays	205 per 100,000 population. This represents 250 stays per year
Estimated levels of adult excess weight	Lower than the England average
Estimated levels of adult smoking	Higher than the England average
The rate of people killed and seriously injured on roads	Lower than the England average
Rates of sexually transmitted infections and TB	Higher than the England average
Rate of violent crime	Higher than the England average
Rates of long term unemployment	Higher than the England average
Rate of early deaths from cardiovascular diseases	Higher than the England average
Rate of early deaths from cancer	Higher than the England average

27.5.3.1.4 Breckland District

90. The health of people in Breckland is varied compared with the England average (Table 27.10).

Table 27.10 Health of people in Breckland (Source: Public Health England, 2017)

Factor	Breckland District compared with England averages
Health of children	
Children live in low income families	16% (3,500). Lower than for England
Child obesity in Year 6 of school	19.4% (235). Higher than the average for England
Alcohol specific hospital stays among those under 18	11 per 100,000 population. This represents 3 stays per year
GCSE attainment	Lower than the England average
Levels of breastfeeding initiation	Higher than the England average
Health of adults	
Life expectancy for women	Higher than the England average
Life expectancy for men	Higher than the England average
Life expectancy in the most deprived areas than the least deprived areas	4.8 years lower for men and 2.5 years lower for women
Rate of alcohol-related harm hospital stays	656 per 100,000 population. This represents 928 stays per year.
Rate of self-harm hospital stays	175 per 100,000 population. This represents 2223 stays per year
Estimated levels of adult excess weight	Lower than the England average
Estimated levels of adult smoking	Higher than the England average
The rate of people killed and seriously injured on roads	Lower than the England average
Rates of sexually transmitted infections and TB	Higher than the England average
Rate of violent crime	Higher than the England average
Rates of long term unemployment	Higher than the England average
Rate of early deaths from cardiovascular diseases	Higher than the England average
Rate of early deaths from cancer	Higher than the England average

27.5.3.2 Noise

91. Noise effects are considered at the site-specific level (representative of landfall, cable route and onshore project substation, see section 27.4.1). Baseline data is discussed accordingly, including reference to local or regional indicators as appropriate.

92. The environmental baseline for noise has been provided in Chapter 25 Noise and Vibration.

93. The human health baseline relevant to this topic from Appendix 27.1 Table 3.1, Table 3.2 and Table 3.3 can be summarised as follows.

94. People who spend extended periods at home may experience greater noise exposure durations than those who are absent during normal working hours (Table 27.11).

Table 27.11 Summary of baseline relevant to Noise and Air Quality (Department of Communities and Local Government, 2015)

Project location	Landfall	Cable Route[2]	Onshore project substation	National
Representative LSOA	North Norfolk LSOA 012A	Breckland LSOA 004C	Breckland LSOA 004A	England average
Households have no adults in employment	40%	32%	52%	33%
Households include dependent children	19%	25%	19%	29%
Households include a person with a long-term health problem or disability	28%	29%	31%	26%
People aged over 65 years old	25%	22%	35%	16%
People report working mainly at or from home	18%	18%	15%	10%
Deprivation can increase sensitivity to change:				
For overall deprivation[6] where 1 is the most deprived LSOA	8,484	8,926	18,957	32,844 LSOAs in England
Relative deprivation by neighbourhoods in England	Within 30% most deprived	Within 30% most deprived	Within 50% most deprived	n/a

95. The indicator for noise effects is not reported on smaller area statistics. Therefore, baseline exposure to transport related noise is considered representative of the regional (County) level. This indicates that 2.1% of people are exposed to road, rail and air transport noise of 65 dB(A) or more during the daytime (compared to an average of 5.2% for England). (PHE 2017a and 2017b)

96. During the night-time transport related noise at the regional (County) level (the indicator not reporting on smaller area statistics) indicates that 3.0% of people are

[6] The index of multiple deprivation is comprised of domains for: income; employment; education, skills and training; health deprivation and disability; crime; barriers to housing and services; and living environment.

exposed to road, rail and air transport noise of 55 dB(A) or more during the night-time (compared to an average of 8.0% for England). The most recent Census data available is from 2011 (PHE 2017a and 2017b).

97. Data from 2015 at the local level indicates a baseline of approximately 4.0 complaints about noise per year per thousand population in North Norfolk District (compared to an estimated value of 7.1 per thousand population in England). In Broadland District the baseline rate is 3.5 noise complaints per thousand population. In Breckland District the baseline rate is 0.5 noise complaints per thousand population (PHE 2017a and 2017b).

27.5.3.3 Air quality

98. Air quality effects are expected at the site specific level (see section 27.4.1). Baseline data is discussed accordingly, including reference to local or regional indicators as appropriate.

99. As with potential noise disturbance, people who spend extended periods at home may experience greater air pollutant exposure durations than those who are absent during normal working hours (as described in Table 27.11).

100. The environmental baseline for air quality has been provided in Chapter 26 Air Quality.

101. The health baseline relevant to this topic from Appendix 27.1 Table 3.1, Table 3.2 and Table 3.3 can be summarised as follows.

102. Data from 2015 at the local level indicates a baseline annual mean concentration of human-made fine particulate matter ($PM_{2.5}$) as shown in Table 27.12. Levels of fine particulate have been used as a general indicator of air quality in this chapter due to increased levels having increased risk to human health in comparison to course particulate (PM_{10}). In comparison to target thresholds these baselines are well below the UK air quality objective (AQO) threshold but close to the WHO guide value. (PHE 2017a and 2017b)

Table 27.12 Indicative air quality level based on fine particulate levels

	North Norfolk	Broadland	Breckland
Annual mean concentration of human-made fine particulate matter ($PM_{2.5}$)	8.29 to 10.70 µg/m^3	8.68 to 10.18 µg/m^3	8.72 to 9.78 µg/m^3
UK AQO target threshold	25 µg/m^3		
WHO guide value	10 µg/m^3		

27.5.3.4 Ground and / or water contamination

103. The environmental baseline for ground conditions and water resources has been provided in Chapter 19 Ground Conditions and Contamination and Chapter 20 Water Resources and Flood Risk respectively.

104. The human health baseline relevant to this topic from Appendix 27.1 Table 3.1, Table 3.2 and Table 3.3 can be summarised as follows.

105. The potential for ground disturbance of historic contamination or new spills of pollutants (such as fuel or oil) to affect communities is dependent on proximity and behavioural exposure influences. This may include use of bathing waters or encountering in-situ or mobilised contamination (dust or aerosols) whilst in the outdoor environment.

106. Compared to adults, children are more vulnerable to water contamination because they would ingest a greater amount as a proportion of body mass. Thus the proportion of the population and the population density is described in Table 27.13.

Table 27.13 Summary of population baseline relevant for water contamination

Project location	Landfall	Cable Route[2]	Onshore project substation	National
Representative LSOA	North Norfolk LSOA 012A	Breckland LSOA 004C	Breckland LSOA 004A	England average
Resident population aged under 16 at the 2011 Census	14%	16%	13%	19%
	Lower than average			
Population density (persons per hectare)	0.7	0.4	1.2	4.1
	Very low compared to average			

27.5.3.5 Physical activity

107. Physical activity effects are expected at the site-specific level (see section 27.4.1). Baseline data is discussed accordingly, including reference to local or regional indicators as appropriate.

108. The human health baseline relevant to this topic from Appendix 27.1 Table 3.1, Table 3.2 and Table 3.3 can be summarised as follows.

109. In site specific populations (Table 27.14) the proportion of people reporting their health to be very good or good is lower than average for England. The proportion reporting fair health is above the average for England. The proportion of people reporting bad or very bad health is slightly higher than the average for England. This is consistent with a lower percentage of people reporting that their day-to-day activities are not limited compared to the average for England. These health statistics are likely to reflect the older age profile of the areas compared to the average for England.

110. At the regional level (Norfolk County) the percentage of people aged 16+ with sports club membership is 19.3% (compared to an average of 22.0% in England, 2015/16 data). Despite these slightly lower membership statistics, the percentage of the adult population that is active (56.5%) is similar to the average for England (57%). This is consistent with a slightly higher percentage of people (18.8%) using outdoor space

for exercise or other health reasons (compared to an average of 17.9% for England). These factors are likely to relate to the rural nature of Norfolk.

111. The representative populations around the project are around the median of relative health deprivation (Table 27.14 – approximately 16 to 19,000 out of 32,844). A higher proportion of households have access to a vehicle which would allow them to access wider physical activity opportunities. But this may be representative of the low population density (Table 27.13) rather than the level of physical activity.

Table 27.14 Summary of baseline for physical activity

Project location	Landfall	Cable Route[2]	Onshore project substation	National
Representative LSOA	North Norfolk LSOA 012A	Breckland LSOA 004C	Breckland LSOA 004A	England average
People reporting their health is very good or good	77%	78%	73%	81%
Proportion reporting fair health	17%	14%	20%	13%
Proportion of people reporting bad or very bad health	6%	9%	7%	5%
People reporting that their day-to-day activities are not limited	77%	79%	72%	82%
Population aged over 65	25%	22%	35%	16%
Health deprivation can increase sensitivity to change:				
For overall deprivation[6] where 1 is the most deprived LSOA	19,670	16,240	16,457	32,844 LSOAs in England
Relative deprivation by neighbourhoods in England	amongst the 50% least deprived neighbourhoods in the country	amongst the 50% most deprived neighbourhoods in the country	amongst the 50% least deprived neighbourhoods in the country	
Access to a vehicle is indicative of being able to access alternative physical activity opportunities:				
Households have a vehicle	92%	92%	87%	74%

27.5.3.6 Journey times and / or reduced access

112. There is potential for journey times and/or access to be affected at the local level (see section 27.4.1). Baseline data is discussed accordingly, including reference to local or regional indicators as appropriate.

113. The environmental baseline for traffic has been provided in Chapter 24 Traffic and Transport.

114. The human health baseline relevant to this topic from Appendix 27.1 Table 3.1, Table 3.2 and Table 3.3 is summarised in Table 27.15. This shows that North Norfolk and Breckland have low access to health assets and tend to travel further to work than average. All local areas have similar or higher rate of death or serious injury on the road. This correlates with the high number of people that have access to a vehicle and the low population (Table 27.13).

Table 27.15 Summary of baseline for journey times and access to services

	North Norfolk	Broadland	Breckland	England
Average distance travelled to work	21km	15km	20km	15km
Baseline rate of people killed or seriously injured on the roads (per 100,000)[7]	40.0	44.0	48.0	39.7
Access to Health Assets & Hazards[8]	29.3%	14.7%	26.0%	21.2%
Access deprivation can increase sensitivity to change:				
For the barriers to housing and services domain of deprivation[9] (where 1 is the most deprived area)	23	134	44	326

27.5.3.7 Employment

115. Employment effects are expected at the regional level (see section 27.4.1). Baseline data is discussed accordingly.

116. The environmental baseline has been provided in Chapter 31 Socio-economics.

117. The human health baseline relevant to this topic from Appendix 27.1 Table 3.1, Table 3.2 and Table 3.3 is summarised in Table 27.16. Chapter 31 Socio-economics indicates there would be an appropriate pool of construction workers who would benefit from employment opportunities associated with the onshore cable laying tasks of the project.

118. Income deprivation in Norfolk County in 2015 was below average compared to that for England. The percentage of older people and children affected by income deprivation are both below the average for England. In terms of gender pay equality; this is currently only slightly below the average for England.

Table 27.16 Summary of employment baseline (Source: NOMIS 2017 and English indices of deprivation 2015)

	Norfolk County	British average
Working age (16-64) people in employment	75.7%	75.1%
People in skilled manual occupations	20.6%	16.5%
People affected by income deprivation	13.2%	14.7%
Older people affected by income deprivation	14.1%	16.2%
Children affected by income deprivation	17.7%	19.9%
Gender pay equality[10]	76.2%	83.3%

[7] Data from 2014 to 2016
[8] Access to Health Assets & Hazards (AHAH) index measures the percentage of the population who live in LSOAs which score in the poorest performing 20% of domains for access to retail services, access to health services, and physical environment.
[9] The barriers to housing and services domain of deprivation is comprised of indictors for: road distance to a post office; road distance to a primary school; road distance to general store or supermarket; road distance to a GP surgery; household overcrowding; homelessness; and housing affordability. Uses rank of average rank.
[10] Ratio between the gross median hourly earnings for women and the gross median hourly earnings for men

27.5.3.8 Electric and magnetic fields

119. Electric and magnetic fields (EMFs) occur naturally and are present everywhere in our environment. Electric fields are measured in volts per metre (V/m) and magnetic fields are produced by current (the flow of electricity) and are measured in microteslas (µT).

120. Both Alternating Current (AC) and Direct Current (DC) fields exist in addition to the Earth's steady natural fields. In AC the voltage, current and corresponding EMF switches direction. Most transmission infrastructure in the UK uses AC. Within the UK, the frequency of AC mains electricity is 50 hertz (Hz, or 50 cycles per second).

121. In a DC system, the voltage and current continue in the same direction. Therefore, the frequency of the EMF is 0Hz and known as a static field, the same as that produced naturally by the earth's magnetic field. Therefore, the magnetic field from a DC system will not induce an electrical current in a conducting medium.

122. Norfolk Boreas Limited has made the decision to use high voltage direct current (HVDC) technology (see section 27.6.1) for the both the offshore and onshore export infrastructure; only a very short distance of high voltage alternating current (HVAC) (400kV underground cables) will be required to connect the onshore project substation with the National Grid substation extension. An onshore project substation is needed to convert DC to AC power so that it can connect to the National Grid

123. The onshore project substation would contain some specialised equipment which could potentially exceed the exposure limits if located close to the perimeter fence. This will be considered in the detailed design to ensure that the design fully complies with the public exposure limits[11].

124. EMF exposure limits for both AC and DC are subject to UK regulations, these limits are outlined in section 27.5.5.1. .

27.5.3.9 Health Priorities

125. Health priorities from the Norfolk Health and Wellbeing Strategy (Norfolk County Council, 2015) and Norfolk Joint Strategic Needs Assessment (JSNA) (Norfolk Health and Wellbeing Board and Norfolk County Council, 2015) have informed this health chapter.

[11] For information on Norfolk Boreas EMF - https://corporate.vattenfall.co.uk/contentassets/bf0e5e31bbab467eaf02040c7b17513a/vattenfall-emf-information-sheet.pdf

126. The Norfolk Health and Wellbeing Strategy outlines the following priority areas:

- *"Promoting the wellbeing of pre-school children;*
- *Reducing obesity; and*
- *Supporting people with dementia and their carers."*

127. Within these priority areas, the strategy provides a number of intentions categorised by prevention, reducing inequality, and integration. The following strategic intentions have the potential to be influenced by the project:

- *"Improving mental health"* of pre-school children may be effected by noise disturbance, or air pollutants if these impacts are found to be significant;
- *"Create a healthier physical environment"* to reduce obesity may be effected if playing fields or public rights of way are significantly affected by the project; and
- *"Improve the dementia care pathway"* as well as *"Improve services for those unable to live independently"* for those with dementia may be effected if it is found that traffic disturbance is significant and may be potentially reducing access to GPs, care homes, or households.

128. These effects may also be felt by people outside of the priority areas as well as discussed in the JSNA with respect to the four key areas, presenting the following findings:

- Population – is 90% white ethnic group with the lowest proportion of other ethnic groups in North Norfolk. Although the area is viewed as having a rural character almost half of residents live in urban areas. As measured by Wellbeing surveys by the ONS, the happiest people live in South Norfolk, and the most satisfied live in North Norfolk.
- Children and Families – North Norfolk has the lowest numbers of children. 17.3% of Norfolk's children live in low income families. The highest levels are in Great Yarmouth and Norwich. Around 1 in 10 children in Reception are classed as obese but this ratio halves to 1 in 5 by Year 6 of school (around 10 years old). There is also a strong emphasis on supporting children in the Early Years (defined as up to the age of 5) because issues in early life can adversely impact on future life chances.
- Working Age Population – around 60% of Norfolk's population are between 16 and 64, which is below the national average suggesting an ageing population. Around 75% are employed, which is above the national average suggesting good employment opportunities.
- 31.7% of adults take part in 30 minutes of moderate intensity sport at least once a week, which is slightly below the national average.
- Around 53 in 100,000 people in Norfolk die prematurely from heart disease, which is below the national average. Life expectancy for both men and women is

approximately 1 year above the national average at 79.7 and 83.6 respectively. This suggests the health of people in Norfolk is generally slightly better than the rest of the UK but health also reduces as deprivation increases.

- Older People – it is projected that by 2021, 25% of Norfolk's population will be over 65. There will also be a 40% growth in those over 85, 27% growth in those from 75 to 84, and a 19% growth in those from 65 to 74. This suggests that people are living longer and as a result the levels of dementia are projected to rise from 15,730 cases in 2017 to 18,240 cases in 2022. Older people are also susceptible to disability as a result or falls and death due to circulatory or respiratory disease during winter.

129. Both the strategy and needs assessment highlight areas that may be adversely affected by the project. Young children and older people may be sensitive to noise and vibration impacts, especially at night when trying to sleep. The significance of potential impact sources are covered in Chapter 25 Noise and Vibration.

130. Similarly, families with young children and the carers of the elderly may be impacted by traffic disturbances if they cannot easily reach facilities such as GPs, care homes, or day care. The significance of potential impact sources are covered in Chapter 24 Traffic and Transport.

131. The districts that the project interacts with have plentiful open space and public rights of ways which facilitate enjoyment of the open space. Reducing access to this may reduce people's ability or enthusiasm to undertake exercise and so maintain their health. The significance of potential impact sources are covered in Chapter 30 Tourism and Recreation.

132. However, the project may also have positive impacts in relation to the priority areas. For example, an increase in local employment and training opportunities may provide skills for young people and income for households with children under five. In the long term, ensuring energy security through renewable generation may reduce electricity bills and allow more older people to afford sufficient energy throughout the winter.

27.5.4 Consultation Responses

133. Consultation is an important component of the EIA 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 human health has been conducted through the Scoping Report (Royal HaskoningDHV, 2017) and the Evidence Plan Process (EPP), namely the Heath Impact Review Method Statement (Royal HaskoningDHV, 2018, unpublished) and the Preliminary Environmental Information Report (PEIR) (Norfolk Boreas Limited, 2018).

134. Feedback received during this process to date has been incorporated into this ES. Consultation responses with regard to the determinants of health considered in this assessment are summarised in Table 27.17.

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

136. Full details of the project consultation process are presented within Chapter 7 Technical Consultation. Table 27.17 includes consultation responses that are specific to human health and direction to consultation responses for supporting information.

Table 27.17 Consultation responses in relation to Human Health

Consultee	Date / document	Comment	Response / where addressed in the ES
Human Health			
Public Health England	June 2017 Scoping	At this point in time, there is no body of evidence conclusively linking wind farms with adverse health effects arising from emissions of chemicals. When operational, wind farms should not produce emissions, pollutants, or waste products. Offshore wind farms are located out to sea, away from members of the public, hence the potential for the public to be affected by any emissions from them is very small.	Norfolk Boreas Limited. welcomes Public Health England's informed and pragmatic position on the health effects of the operation of offshore wind farms.
Public Health England	June 2017 Scoping	There is potential for impacts to arise during the construction and decommissioning phases from the transport of material and equipment (e.g. accidental leaks, spills, and releases). The movement of material off-site has the potential to lead to impacts, if not properly managed (e.g. associated with contaminated land or dredged sediment). PHE would expect the applicant to adhere to best practice guidance during these phases and for them to ensure that potential impacts are assessed and minimised.	Potential effects are covered in section 27.6 Impacts due to ground contamination are detailed in Chapter 19 Ground Conditions and Contamination Impacts due to transport and traffic change are detailed in Chapter 24 Traffic and Transport. Best practice guidance will be followed

Consultee	Date / document	Comment	Response / where addressed in the ES
			throughout every phase of the project under both scenarios.
Public Health England	June 2017 Scoping	PHE provides advice on standards of protection for exposure to non-ionising radiation, including the static magnetic fields, and power frequency electric and magnetic fields associated with wind farm power lines and associated equipment.	PHE advice has been included in section 27.5.3.8, section 27.5.5.1 and section 27.6.5.2
Expert Topic Group (Norfolk County Council, Breckland Council, Broadland District Council, North Norfolk District Council)	January 2018 Human Impact Review Method Statement	No comments on proposed methodology.	No action required.
Public Health England	October 2018 PEIR	We have considered the submitted documentation and can confirm that we are satisfied with the approach taken in preparing the Environmental Statement (ES) and the conclusions drawn. We wish to make no further comment at this time.	No action required.
Noise			
Detailed in Chapter 25 Noise and Vibration			
Air quality			
Detailed in Chapter 26 Air Quality			
Ground and / or water contamination			
Detailed in Chapter 19 Ground Conditions and Contamination and Chapter 20 Water Resource and Flood Risk			
Physical activity			
Consultation comments specific to this topic were not received but consultation with regard to tourism and recreation are relevant. These are detailed in Chapter 30 Tourism and Recreation			
Journey times and/or reduced access			
Detailed in Chapter 24 Traffic and Transport			
Employment			
Detailed in Chapter 31 Socio-economics			

27.5.5 Policy Context

137. National Policy Statements (NPS) produced by the UK Government set the policy context for the development of new energy infrastructure in the UK. Table 27.18 summarises the relevant health provisions of the NPS for Overarching Energy (EN-1) (Department of Energy and Climate Change, 2011c), which informs the NPS for Renewable Energy (EN-3) (Department of Energy and Climate Change, 2011b); and the NPS for Electricity Networks (EN-5) (Department of Energy and Climate Change, 2011a). However, EN-5 has been included under EMF due to its specific guidance in this area.

Table 27.18 Review of National Policy Statements with regards health determinants

Section	Description	Response
General		
EN-1, 4.10	Issues relating to discharges or emissions from a proposed project which affect air quality, water quality, land quality and the marine environment, or which include noise and vibration may be subject to separate regulation under the pollution control framework or other consenting and licensing regimes. The planning and pollution control systems are separate but complementary. The planning system controls the development and use of land in the public interest. It plays a key role in protecting and improving the natural environment, public health and safety, and amenity, for example by attaching conditions to allow developments which would otherwise not be environmentally acceptable to proceed and preventing harmful development which cannot be made acceptable even through conditions. Pollution control is concerned with preventing pollution through the use of measures to prohibit or limit the releases of substances to the environment from different sources to the lowest practicable level. It also ensures that ambient air and water quality meet standards that guard against impacts to the environment or human health. In considering an application for development consent, the Infrastructure Planning Commission (IPC) [*now the Planning Inspectorate and the Secretary of State*] should focus on whether the development itself is an acceptable use of the land, and on the impacts of that use, rather than the control of processes, emissions or discharges themselves. The IPC should work on the assumption that the relevant pollution control regime and other environmental regulatory regimes, including those on land drainage, water abstraction and biodiversity, will be properly applied and enforced by the relevant regulator. It should act to complement but not seek to duplicate them.	Potential discharges and emissions are considered in: Chapter 09 Marine Water and Sediment Quality Chapter 19 Ground Conditions and Contamination Chapter 20 Water Resources and Flood Risk Chapter 26 Air Quality
EN-1, 4.13	As described in the relevant sections of this NPS and in the technology- specific NPSs, where the proposed project has an effect on human beings, the Environmental Statement (ES) should assess these effects for each element of the project, identifying any adverse health impacts, and identifying measures to avoid, reduce or compensate for these impacts as appropriate. The impacts of more than one development may affect people simultaneously, so the applicant and the IPC should consider the cumulative impact on health.	Effects on human beings are considered in: Section 27.6 Chapter 30 Tourism and Recreation Chapter 31 Socio-economics

Section	Description	Response
Noise		
EN-1, 4.13	The direct impacts on health may include increased noise. The IPC will want to take account of health concerns when setting requirements relating to a range of impacts such as noise.	Chapter 25 Noise and Vibration considers direct noise impacts
EN-1, 5.11	The IPC should not grant development consent unless it is satisfied that the proposals will meet the following aims: • Avoid significant adverse impacts on health and quality of life from noise; • Mitigate and minimise other adverse impacts on health and quality of life from noise; and • Where possible, contribute to improvements to health and quality of life through the effective management and control of noise.	Potential noise effects are considered in section 2.6.3.1
EN-1, 5.11	Excessive noise can have wide-ranging impacts on the quality of human life, health (for example owing to annoyance or sleep disturbance) and use and enjoyment of areas of value such as quiet places and areas with high landscape quality. The Government's policy on noise is set out in the Noise Policy Statement for England. It promotes good health and good quality of life through effective noise management. Similar considerations apply to vibration, which can also cause damage to buildings. In this section, in line with current legislation, references to "noise" below apply equally to assessment of impacts of vibration.	Potential health effects are considered in section 27.6.3.1 and section 27.6.5.1
Air quality		
EN-1, 4.13	The direct impacts on health may include increased air pollution, dust or odour.	Chapter 26 Air Quality considers direct air quality impacts
EN-1, 4.13	Generally, those aspects of energy infrastructure which are most likely to have a significantly detrimental impact on health are subject to separate regulation (for example for air pollution) which will constitute effective mitigation of them, so that it is unlikely that health concerns will either constitute a reason to refuse consents or require specific mitigation under the Planning Act 2008.	Potential health effects are considered in section 27.6.3.2
Ground and / or water contamination		
EN-1, 4.13	The direct impacts on health may include increased hazardous waste and substances or increased water pollution.	Direct effects are considered in: Chapter 09 Marine Water and Sediment Quality Chapter 19 Ground Conditions and Contamination Chapter 20 Water Resources and Flood Risk Potential health effects are
EN-1, 5.14	Government policy on hazardous and non-hazardous waste is intended to protect human health and the environment by producing less waste and by using it as a resource wherever possible. Where this is not possible, waste management regulation ensures that waste is disposed of in a way that is least damaging to the environment and to human health.	
EN-1, 5.15	Infrastructure development can have adverse effects on the water environment, including groundwater, inland surface water, transitional waters and coastal waters. During the construction, operation and decommissioning stages, it can lead to increased demand for water, involve discharges to water and cause adverse ecological effects resulting from physical modifications to the water environment. There may also be an increased risk of spills and leaks of pollutants to the water environment. These effects could lead to adverse impacts on health or on protected species and habitats and	

Section	Description	Response
	could, in particular, result in surface waters, groundwaters or protected areas failing to meet environmental objectives established under the Water Framework Directive.	considered in section 27.6.3.3
Physical activity		
EN-1, 4.13	New energy infrastructure may also affect the composition, size and proximity of the local population, and in doing so have indirect health impacts, for example if it in some way affects access to the use of open space for recreation and physical activity.	Effects on populations are considered in: Chapter 30 Tourism and Recreation Chapter 31 Socio-economics Potential health effects are considered in section 27.6.3.4
EN-1, 5.10	The Government's policy is to ensure there is adequate provision of high quality open space (including green infrastructure) and sports and recreation facilities to meet the needs of local communities. Open spaces, sports and recreational facilities all help to underpin people's quality of life and have a vital role to play in promoting healthy living. Green infrastructure in particular will also play an increasingly important role in mitigating or adapting to the impacts of climate change.	
EN-1, 5.10	Applicants will need to consult the local community on their proposals to build on open space, sports or recreational buildings and land. Taking account of the consultations, applicants should consider providing new or additional open space including green infrastructure, sport or recreation facilities, to substitute for any losses as a result of their proposal. Applicants should use any up-to-date local authority assessment or, if there is none, provide an independent assessment to show whether the existing open space, sports and recreational buildings and land is surplus to requirements.	
Journey times and / or reduced access		
EN-1, 4.13	The direct impacts on health may include increased traffic.	Direct effects are considered in Chapter 24 Traffic and Transport Potential health effects are considered in section 27.6.3.5
EN-1, 4.13	New energy infrastructure may also affect the composition, size and proximity of the local population, and in doing so have indirect health impacts, for example if it in some way affects access to transport or key public services.	
Employment		
EN-1, 4.2	To consider the potential effects, including benefits, of a proposal for a project, the IPC will find it helpful if the applicant sets out information on the likely significant social and economic effects of the development, and shows how any likely significant negative effects would be avoided or mitigated. This information could include matters such as employment, equality, community cohesion and well-being.	Employment is considered in Chapter 31 Socio-economics Potential health effects are considered in section 27.6.4
Electromagnetic fields (EMF)		
EN-1, 4.13	The direct impacts on health may include increased exposure to radiation.	Potential health effects are considered in section 27.6.5.2
EN-5 2.10	The International Commission on Non-Ionizing Radiation Protection (ICNIRP21) developed health protection guidelines in 1998 for both public and occupational exposure. These are expressed in terms of the induced current density in affected tissues of the body, "basic	

Section	Description	Response
	restrictions", and in terms of measurable "reference levels" of electric field strength (for electric fields), and magnetic flux density (for magnetic fields).	Exposure limits are discussed below in section 27.5.6.1 and assessed in section 27.6.5.2
EN-5 2.10	The balance of scientific evidence over several decades of research has not proven a causal link between EMFs and cancer or any other disease. The Health Protection Agency's Centre for Radiation, Chemical and Environmental Hazards keeps under review emerging scientific research and/or studies that may link EMF exposure with various health problems and provides advice to the Department of Health on the possible need for introducing further precautionary measures.	

27.5.5.1 EMF Exposure limits

138. Due to the fact that EMF from AC induces a current in a conducting medium and EMF from DC does not, two different exposure limits are considered under UK regulations. It should be noted that the majority of onshore underground cabling for Norfolk Boreas is HVDC and only a short section connecting the onshore project substation with the Necton National Grid substation will be HVAC.

139. In March 2004, the National Radiological Protection Board (NRPB) provided new advice to the Government, replacing previous advice from 1993, and recommending the adoption in the UK of guidelines published in 1998 by the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 1998). On 1 April 2005, the NRPB joined the Health Protection Agency, becoming the Radiation Protection Division. In 2013 this then became Public Health England. Table 27.19 summarises the recommended values.

Table 27.19 Recommended Values for Power Frequencies

Public exposure level	Electric Fields	Magnetic Fields
Power frequency		
Basic restriction (induced current density in central nervous system)	2mA/m2	
Reference level (external unperturbed field)	5,000V/m	100µT
Field corresponding to the basic restriction	9,000V/m	360µT
Static		
Basic restriction	None	40,000µT

27.5.5.1.1 Alternating Current fields exposure limits

140. In recommending these levels, the NRPB considered the evidence for all suggested effects of EMFs. It concluded that the evidence for effects on the nervous system caused by currents induced by the fields was sufficient to justify setting exposure limits, and this is the basis of their quantitative recommendations (NRPB, 2004). It concluded that the evidence for effects at lower fields, for example the evidence relating to childhood leukaemia, was not sufficient to justify setting exposure limits,

but was sufficient to justify recommending that the Government consider possible precautionary actions. Precautionary measures are considered in more detail below.

141. The EMF guidelines are documented in NPS EN-5 and practical details of their application are explained in the Code of Practice, 'Power Lines: Demonstrating compliance with EMF public exposure guidelines – a voluntary Code of Practice' published by the Department of Energy and Climate Change (DECC, 2012). It is the electricity industry's policy to comply with the Government guidelines on EMF, and this Code of Practice forms an integral part of this policy.

142. The ICNIRP guidelines (ICNIRP, 1998) are set so as to prevent external exposure to EMFs that could cause currents to be induced in the body large enough to cause effects on nerves, with a substantial safety margin. These induced currents can be expressed as a current density and it is on current density that the guidelines are based. The ICNIRP guidelines recommend that the general public are not exposed to levels of EMFs able to cause a current density of more than 2mA/m2 within the human central nervous system, as shown in Table 27.19 above. This recommendation is described as the "basic restriction". The external fields that have to be applied to the body to cause this current density have to be calculated by numerical dosimetry, since in-vivo measurements of current density are not practical.

143. The ICNIRP guidelines also contain "reference levels". For the public, the reference level for electric fields is 5kV/m, and the reference level for magnetic fields is 100µT. The 1999 EU Recommendation (EU Council, 1999) uses the same values as ICNIRP (ICNIRP, 1998).

144. In the ICNIRP guidelines and the EU Recommendation, the actual limit is the basic restriction. The reference levels are not limits, but are guides to when detailed investigation of compliance with the actual limit, the basic restriction, is required. If the reference level is not exceeded, the basic restriction cannot be exceeded and no further investigation is needed. If the reference level is exceeded, the basic restriction may or may not be exceeded.

145. The Code of Practice on compliance (DECC, 2012) endorses this approach and gives the values of field corresponding to the basic restriction, stating:

146. "*The 1998 ICNIRP exposure guidelines specify a basic restriction for the public which is that the induced current density in the central nervous system should not exceed 2mA m-2. The Health Protection Agency specify that this induced current density equates to uniform unperturbed fields of 360µT for magnetic fields and 9.0kV m-1 for electric fields. Where the field is not uniform, more detailed investigation is needed. Accordingly, these are the field levels with which overhead power lines (which*

produce essentially uniform fields near ground level) shall comply where necessary. For other equipment, such as underground cables, which produce non-uniform fields, the equivalent figures will never be lower but may be higher and will need establishing on a case-by-case basis in accordance with the procedures specified by HPA. Further explanation of basic restrictions, reference levels etc. is given by the Health Protection Agency."

147. The Code of Practice (DECC, 2012) also specifies the land uses where exposure is considered to be for potentially a significant period of time and therefore where the public guidelines apply. These land uses are, broadly, residential uses and schools.

148. Therefore, if the EMFs produced by an item of equipment are lower than 9kV/m and 360µT, the fields corresponding to the ICNIRP basic restriction, it is compliant with the ICNIRP guidelines and hence with PHE recommendations and Government policy. If the fields are greater than these values, the equipment is still compliant with Government policy if the land use falls outside residential use and other uses specified in the Code of Practice (DECC, 2012) and it may still be compliant if the fields are non-uniform.

27.5.5.1.2 Direct Current static fields exposure limits

149. The 1998 ICNIRP Guidelines cover only AC fields, not DC fields. For DC fields, the 1999 EU Recommendation uses the values from the earlier 1994 ICNIRP Guidelines (ICNIRP, 1994) for static magnetic fields. The 1994 ICNIRP limit for static magnetic fields, included in the EU Recommendation, is 40, 000µT. In accordance with the EU Recommendation, this only applies where the time of exposure is significant.

150. The 1999 EU Recommendation does not contain any limits for static electric fields. Instead, there is a statement: "For most people, the annoying perception of surface electric charge will not occur at field strengths less than 25 kV/m. Spark discharges causing stress or annoyance should be avoided."

27.6 Potential Effects

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

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

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

27.6.1 Embedded Mitigation

153. Norfolk Boreas 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.

154. A range of different information sources has been considered as part of embedding mitigation into the design of the project. These include engineering requirements, feedback from the community and landowners, ongoing discussions with stakeholders and regulators, commercial considerations and environmental best practice. For further details see Chapter 5 Project Description, Chapter 4 Site Selection and Assessment of Alternatives and the Consultation Report (document reference 5.1).

155. The following sections outline the key embedded mitigation measures relevant for this assessment. These measures are presented in Table 27.20. Where embedded mitigation measures have been developed into the design of the project with specific regard to human health these are described in Table 27.21.

Table 27.20 Embedded mitigation

Parameter	Mitigation measures embedded into the project design	Notes
Project Wide		
Commitment to HVDC technology	Commitment to HVDC technology minimises environmental impacts through the following design considerations; • HVDC requires fewer cables than the HVAC solution. During the duct installation phase under Scenario 2 this reduces the cable route working width for Norfolk Boreas to 35m from the previously identified worst case of 50m. As a result, the overall footprint of the onshore cable route required for the duct installation phase is reduced from approx. 300ha to 210ha; • The width of permanent cable easement is also reduced from 25m to 13m; • Removes the requirement for a cable relay station as permanent above ground infrastructure; • Reduces the maximum duration of the cable pulling phase from three years down to two years;	Norfolk Boreas Limited has reviewed consultation received and in light of the feedback, has made a number of decisions in relation to the project design. One of these decisions is to deploy HVDC technology as the export system.

Parameter	Mitigation measures embedded into the project design	Notes
	• Reduces the total number of jointing pits for Norfolk Boreas from 450 to 150; and • Reduces the number of drills needed at trenchless crossings (including landfall).	
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 explanation see Chapter 4 Site Selection and Alternatives) for the onshore project substations and National Grid substation extension and associated infrastructure, a preference for the shortest route length (where practical) and developing construction methodologies to minimise potential impacts. Key design principles from the outset were followed (wherever practical) and further refined during the EIA process, including; • Avoiding proximity to residential dwellings; • Avoiding proximity to historic buildings; • Avoiding designated sites; • Minimising impacts to local residents in relation to access to services and road usage, including footpath closures; • Utilising open agricultural land, therefore reducing road carriageway works; • Minimising requirement for complex crossing arrangements, e.g. road, river and rail crossings; • Avoiding areas of important habitat, trees, ponds and agricultural ditches; • Installing cables in flat terrain maintaining a straight route where possible for ease of pulling cables through ducts; • Avoiding other services (e.g. gas pipelines) but aiming to cross at close to right angles where crossings are required; • Minimising the number of hedgerow crossings, utilising existing gaps in field boundaries; • Avoiding rendering parcels of agricultural land inaccessible; and • Utilising and upgrading existing accesses where possible to avoid impacting undisturbed ground.	Constraints mapping and sensitive site selection to avoid a number of impacts, or to reduce impacts as far as possible, is a type of primary mitigation and is an inherent aspect of the EIA process. Norfolk Boreas Limited has reviewed consultation received to inform the site selection process (including 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.
Long horizontal directional drilling (HDD) at Landfall	Use of long HDD at landfall to avoid restrictions or closures to Happisburgh beach and retain access to the beach for the public during construction. Norfolk Boreas Limited have also committed to not using the beach car park at Happisburgh South.	Norfolk Boreas Limited has reviewed consultation received and in response to feedback, has made a number of decisions in relation to the project design. One of those decisions is to use long HDD at landfall.

Parameter	Mitigation measures embedded into the project design	Notes
Scenario 1		
Strategic approach to delivering Norfolk Boreas and Norfolk Vanguard	Under Scenario 1, onshore ducts will be installed for both projects at the same time as part of the Norfolk Vanguard construction works. This would allow the main civil works for the cable route to be completed in one construction period and in advance of cable delivery, preventing the requirement to reopen the land in order to minimise disruption. Onshore cables would then be pulled through the pre-installed ducts in a phased approach at later stages. In accordance with the Horlock Rules, the co-location of Norfolk Boreas and Norfolk Vanguard onshore project substations will keep these developments contained within a localised area and, in so doing, will contain the extent of potential impacts.	The strategic approach to delivering Norfolk Boreas and Norfolk Vanguard has been a project commitment from the outset of each project.
Scenario 2		
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 also minimise overall disruption.	This has been a very early project commitment. Chapter 5 Project Description provides a detailed description of the process.
Trenchless crossings	Commitment to trenchless crossing techniques to minimise impacts to the following specific features; • Wendling Carr County Wildlife Site; • Little Wood County Wildlife Site; • Land South of Dillington Carr County Wildlife Site; • Kerdiston proposed County Wildlife Site; • Marriott's Way County Wildlife Site / Public Right of Way; • Paston Way and Knapton Cutting County Wildlife Site; • Norfolk Coast Path; • Witton Hall Plantation along Old Hall Road; • King's Beck; • River Wensum; • River Bure; • Wendling Beck; • Wendling Carr; • North Walsham and Dilham Canal; • Network Rail line at North Walsham that runs from Norwich to Cromer; • Mid-Norfolk Railway line at Dereham that runs from Wymondham to North Elmham; and • Trunk Roads including A47, A140, A149.	A commitment to a number of trenchless crossings at certain sensitive locations was identified at the outset. However, Norfolk Boreas Limited has committed to certain additional trenchless crossings as a direct response to stakeholder requests.

Table 27.21 Embedded mitigation for human health

Parameter	Mitigation measures embedded into the project design	Notes
EMF	Norfolk Boreas Limited would comply with Government policy on EMF exposure limits. Norfolk Boreas' commitment to using HVDC avoids many of the potential health risks sometimes associated with HVAC equipment. DC circuits create a static magnetic field that does not generate a current in a conducting medium (such as the human body) and therefore avoids the potential for health effects.	Further detail in section 27.5.3.8 and section 27.6.5.2
Commitment to no overhead lines	The commitment to use underground cable systems for the onshore cable route over the 60km route between the landfall and electrical connection point at the onshore project substation, avoids the requirement to construct new overhead lines. The mitigation embedded in this approach will lead to notably reduced impacts on landscape and visual receptors during the operational phase of the project, despite having a slightly greater impact during construction. It also notably reduces the potential for the onshore cable route to contribute to significant cumulative effects. Owing to the decision to the use of underground cabling; post construction the onshore cable route will have a negligible impact on landscape and visual receptors as the components will be buried under ground, with the exception of the small scale link boxes.	Further details provided in Chapter 5 Project Description and Chapter 4 Site Selection
Strategic landscape mitigation	Mitigation measures associated with the onshore project substation, National Grid substation extension and A47 form part of a strategic approach to enhancing landscape character and bio-diversity in the local area. Figure 29.12 shows how mitigation planting will contribute to the wider landscape structure of the area and help consolidate green corridors for wildlife. Mitigation planting for the onshore project substation is shown in Figure 29.9a. This has been designed to screen the onshore project substation. Details of the mitigation planting are presented in section 29.7.1. Mitigation planting for the National Grid substation extension is shown in Figure 29.10a. This has been designed to screen the National Grid substation extension in views from Necton. Details of the mitigation planting are presented in section 29.7.1.	Further details provided in Chapter 27 Landscape and Visual Impact Assessment, Chapter 22 Onshore Ecology and in the Outline Landscape and Ecological Management Strategy (OLEMS) (document reference 8.7).

27.6.2 Worst Case

156. Chapter 5 Project Description details the design parameters of the project using the Rochdale Envelope approach for this ES. This section identifies those parameters during construction, operation and decommissioning relevant to potential effects on human health. Where the worst case differs between the two scenarios, these are listed below.

157. During offshore construction, there will be a requirement for a dockside marshalling facility, where components for the offshore infrastructure will be stored prior to loading onto construction barges or vessels. These facilities will be chosen with regard to the location of fabricators and original equipment manufacturers (to minimise transportation requirements) and availability of suitable dockside space. A decision on these primary facilities for the project has not yet been made and this would be decided post-consent.

158. The primary base for the operations and maintenance (O&M) facility for Norfolk Boreas and Norfolk Vanguard would likely be a suitable port facility on the coast of East Anglia. At present Norfolk Boreas Limited and Norfolk Vanguard Limited are in negotiations with Peel Ports about a strategic wind farm investment for an offshore operations base on the Norfolk coast; however, at time of writing the precise port is yet to be confirmed.

27.6.2.1 Scenario 1

159. Under Scenario 1, duct installation to house the cables for Norfolk Boreas would be installed by Norfolk Vanguard; therefore construction activities along the cable route would be limited to the pulling of cables through the pre-installed ducts and the construction of jointing pits and link boxes (see Chapter 5 Project Description). Norfolk Boreas would also undertake construction works at the landfall including construction of landfall compounds, duct installation at landfall via horizontal directional drilling(HDD) as well as cable pulling and the construction of associated transition pits and link boxes. Norfolk Boreas would also be required to undertake construction works associated with the onshore project substation, including all pre-construction works and extension of the access road, as well as an easterly extension to the existing Necton National Grid substation.

160. The worst case under this scenario is outlined in Table 27.22; this uses worker transport modelling data detailed in Chapter 24 Traffic and Transport as a basis for labour demand. These assume that the primary works stage will be undertaken during 2024 and 2025 with peak employment of 100 people per week during the first three quarters (Q1 to Q3) of 2025. Cable pulling works are assumed to be undertaken during 2026 and 2027 with an expected peak employment of 170 during the second quarter (Q2) of 2026. For further details on the indicative construction programme under Scenario 1 please see Chapter 5 Project Description.

Table 27.22 Worst case assumptions Scenario 1

Worst case assumptions Parameter	Worst case criteria	Worst case definition	Notes
Landfall			
Construction	Method	Trenchless technique (e.g. HDD)	HDD.
	Drill length	1,000m	Indicative length
	Maximum number and maximum land take for temporary landfall compounds	6,000m^2	Assumes two compounds at 3,000m^2 (50m x 60m) to support parallel drilling rigs.
	Landfall transition pits maximum footprint	1,500m^2	Two pits in total, one pit required per circuit. 10m x 15m x 5m deep.
	Maximum temporary works duration	20 weeks	Based on 7am-7pm normal working hours. 7 Days a week.
Onshore cable route			
Construction – cable pulling only	Method	Pulling of cables through pre-installed ducts	Cables will be pulled through the ducts installed by Norfolk Vanguard.
	Installation maximum footprint	85,500m^2	Cable pull footprint includes the running track and jointing pits
	Running Track width and length	6m and 12km	
	Excavated material for running track	21,600m^2	Volume based on worst case assumption of reinstallation of 12km length of the running track, with a width of 6m and a depth of 0.3m
Permanent jointing pits	Maximum number and required dimensions	Assume 150 at 90m^2 and 2m deep each	Dimensions 6m (w) x 15m (l). Spaced approximately one per circuit per 800m cable.
Permanent link boxes	Maximum number and required dimensions	Assumes 24 at 1.5m x 1.5m if below ground; or 1.2m x 0.8m x 1.8m if above ground	1 link box per circuit typically be placed at 5.0 km intervals . Type of link box and exact locations to be defined during detailed design.
	Access to link boxes	Annual	Periodic access to installed link boxes may be required for inspection, estimated to be annually.

Worst case assumptions Parameter	Worst case criteria	Worst case definition	Notes
Construction programme	Cable pulling works	2026-2027	2 years phased cable pulling
	Peak onshore construction employment	Peak employment of 180[12] during Q2 of 2026	This indicative figure includes the workforce for both the cable route sections and onshore project substation. Assumes five day working week (Monday – Friday) and 7am to 7pm working hours. See chapter 24 Traffic and Transport for further details (section 24.7.2.2.4)
Decommissioning	Method	Jointing pits and ducts left in-situ	Where cables are in pre-installed ducts, cables may be extracted once de-energised.
Onshore project substation			
Construction	Maximum land take for construction works at the onshore project substation	95,000m^2	Operational area for substation (250m x 300m) plus temporary construction compound (200m x 100m). Spicers Corner compound 100 x 100m.
	Maximum land take for temporary works area at Spicers Corner	10,000m^2	
	Maximum duration of construction works	30 months	Indicative construction window 24 months.
Operation	Maximum land take for permanent footprint area	75,000m^2	The total land requirement for the onshore project substation to the perimeter fence is 250m x 300m
	Maximum land take for access road	1,800 m^2	Dimensions 300m x 6m.
	Maximum height of onshore project substation	19m building with 25m lightning protection masts, fences 3.4m high.	

[12] 70% of workers from outside Norfolk/Suffolk area

Worst case assumptions Parameter	Worst case criteria	Worst case definition	Notes
	Maximum access requirement to onshore project substation	One visit per week on average	Site lighting required during maintenance visits
	Expected noise level	See Chapter 25 Noise and Vibration section 25.8.5	
National Grid substation extension and overhead line modification			
Construction	Maximum land take for construction works at substation extension	95,250m^2	Operational area (135m x 150m) plus temporary compound adjacent to eastern extension site (150m x 200m) and compound adjacent to the Norfolk Vanguard Extension (300m x 150m).
	Maximum duration	30 months	Indicative construction window 24 months.
Operation	Maximum land take for substation extension - permanent footprint	20,250m^2	Permanent eastern extension footprint approx. 135m length and 150m wide
	Maximum height of perimeter fencing	4m	2.4m palisade (outer) and 4m electrified (inner)
	Access	One visit per week	Site lighting required during maintenance visits

161. Cables will be pulled through the ducts installed by Norfolk Vanguard using either a single phase or two phased approach. Chapter 5 Project Description outlines the indicative timings in relation to this phasing of works. In all cases for human health; the two phase option, where cables are installed in two consecutive years to facilitate the commissioning of the offshore wind turbine planting, is assumed to be the worst case. This is due to the increased length of time that receptors will be potentially impacted by the project.

27.6.2.2 Scenario 2

162. Under Scenario 2 Norfolk Boreas will be responsible for constructing all of the onshore infrastructure for the project. It is expected that the onshore cable route will be constructed through 2021 and 2026 (pre-construction works to take place between 2021- 2022 and duct installation to commence in 2023). The worst case scenario (Table 27.26) uses worker transport modelling detailed in Chapter 24 Traffic and Transport as a basis for labour demand. Further details on the indicative construction programme under Scenario 2 please see Chapter 5 Project Description.

Table 27.23 Worst case assumptions Scenario 2

Worst case assumptions Parameter	Worst case criteria	Worst case definition	Notes
Landfall			
Construction	Method	Trenchless technique (e.g. HDD)	Assumes 2 drilling rigs working in parallel
	Drill length	1,000m	Indicative length
	Maximum number and maximum land take for temporary landfall compounds	6,000m^2	Assumes two compounds at 3,000m2 (50m x 60m) to support parallel drilling rigs.
	Landfall transition pits maximum footprint	1,500m^2	Two pits in total, one pit required per circuit. 10m x 15m x 5m deep.
	Maximum temporary works duration	20 weeks	Based on 7am-7pm normal working hours. 7 Days a week.
Onshore cable route			
Construction	Onshore construction employment	Peak employment of 280[13] during construction peaks. It is expected that during standard construction works, the onshore workforce will be an average of 100 people.	Assumes five day working week (Monday – Friday) and 7am to 7pm working hours. See chapter 24 Traffic and Transport for further details (section 24.7.3.2.4)
	Method	Open cut trenching and trenchless crossing methods	Trenchless crossing methods (HDD, micro tunnelling or auger boring).
	Maximum working width and length	35m and 60km	
	Onshore cable route maximum footprint	2,100,000m^2	60km length of cable route x 35m working width
	Running Track width and length	6m and 60km	
	Hedgerows to be removed	165[14]	

[13] 70% of workers from outside Norfolk/Suffolk area

[14] Hedgerows estimated based on 110 hedgerows surveyed within the onshore infrastructure plus a further 55 identified from the Norfolk Living Map and aerial photography taken in 2017. The final number of hedgerows

Worst case assumptions Parameter	Worst case criteria	Worst case definition	Notes
	Indicative window of pre-construction works	2021-2022	2 years
	Indicative window of ducting installation	2023-2024	2 years
	Indicative cable pulling window	2025-2026	2 years
	Total maximum onshore construction window	2021-2026	6 years
Permanent jointing pits	Maximum number and required dimensions of permanent jointing pits	Assumes 150 pits at 90m^2 and 2m deep per pit	Dimensions 6m (w) x 15m (l). Spaced approximately one per circuit per 800m cable.
Permanent link boxes	Maximum number and required dimensions of permanent link boxes	Assumes 24 at 1.5m x 1.5m if below ground; and 1.2m x 0.8m x 1.8m if above ground	1 link box per circuit typically be placed at 5.0 km intervals. Type of link box and exact locations to be defined during detailed design. Above ground boxes typically sited on a 0.15m deep concrete slab.
	Access to link boxes	Annual	Periodic access to installed link boxes may be required for inspection, estimated to be annually.
Onshore project substation			
Construction	Maximum land take for construction of onshore project substation	95,000m^2	Operational area for substation 250m x 300m= 75,000m^2 plus additional temporary construction compound 20,000m^2.
	Maximum duration of construction works	30 months	Indicative construction window 24 months.
	Maximum land take for access road.	10,800m^2	Dimensions 1.8km x 6m. New access road from A47.
Operation	Maximum land take for permanent footprint area	75,000m^2	The total land requirement for the onshore project substation to the perimeter fence is 250m x 300m

to be removed will be determined during surveys of the unsurveyed areas post-consent when access becomes available.

Worst case assumptions Parameter	Worst case criteria	Worst case definition	Notes
	Maximum height of onshore project substation	19m building with 25m lightning protection masts, fences 3.4m high.	
	Maximum access requirement to onshore project substation	One visit per week on average	Site lighting required during maintenance visits
	Expected noise level	See Chapter 25 Noise and Vibration section 25.8.5	
National Grid substation extension and overhead line modifications			
Construction	Maximum land take for construction works at substation extension	97,500m^2	Operational area (200m x 150m) plus temporary compounds (150m x 150m and 300m x 150m).
	Maximum land take for temporary works area – overhead line	176,310 m^2	
	Maximum duration	30 months	Indicative construction window 24 months.
Operation	Maximum land take for substation extension - permanent footprint	30,000m^2	Permanent western extension footprint approx. 200m length and 150m wide
	Height of fencing	4m	2.4m palisade (outer) and 4m electrified (inner)
	Maximum land take for overhead line permanent footprint	Up to 1,000m^2	Assumes two new permanent overhead line towers will be required.
	Maximum height of new/replacement towers	55m	The existing corner tower will be demolished such that the net new number of towers is one.
	Access	One visit per week	Site lighting required during maintenance visits

27.6.3 Potential Effects during Construction

163. This section considers the potential effects during the construction phase, the following assessments are based on topics which are discussed in section 27.4.2.1. The methods used for the assessment are outlined in section 27.3. Throughout this section; the general effects are first discussed, followed by the potential causal pathway, each scenario is then assessed based upon these elements.

164. Under Scenario 1 Norfolk Vanguard would have installed the ducts for Norfolk Boreas and therefore construction works under this scenario are limited to landfall, cable pulling works, and at the onshore project substation (including the National Grid substation extension). Under Scenario 2 Norfolk Boreas would be responsible for construction of all required onshore infrastructure.

27.6.3.1 Noise effects

165. During construction, there is potential for noise to temporarily arise from construction works and movement of heavy goods vehicles across the onshore project area.

166. The population groups relevant to this assessment, due to either proximity or other sensitivity are (as defined in section 27.4.1.2):

- The population near landfall (site-specific);
- The population along the onshore cable route (site-specific);
- The population near the onshore project substation and National Grid substation extension (site-specific);
- Children and young people;
- Older people; and
- People with existing poor health (physical and mental health).

167. The key health outcomes relevant to noise as a determinant of health are cardiovascular health (only as a result of chronic noise effects), mental health (including stress, anxiety or depression as a result of chronic noise effects) and cognitive performance in children, particularly at school. This is particularly relevant to two of the health priorities (section 27.5.3.9) outlined by Norfolk County Council, care for the elderly and support to young children.

168. The temporal scope for this effect (as described in section 27.4.1.4) varies depending on the area of the project and scenario.

169. The conclusions of Chapter 25 Noise and Vibration are summarised in sections 27.6.3.1.1 and 27.6.3.1.2 for Scenario 2 and Scenario 1 respectively. The mitigation measures taken into consideration during the assessment are described in Chapter

25 Noise and Vibration. Further details regarding mitigation are also outlined within the outline Code of Construction Practice (CoCP) (document reference 8.1).

170. The potential health effect is considered likely because (based on the methods described in section 27.3.4) there is a plausible source-pathway-receptor relationship where:

- The source is the construction areas and operations;
- The pathway is pressure waves through the air; and
- Receptors are communities of people.

171. Furthermore, the potential effect is probable as no unusual conditions are required for the source-pathway-receptor linkage.

172. The sensitivity of the general population and particularly for vulnerable groups (collectively as a single group) is characterised as follows (based on the methods described in section 27.3.4).

- The general population is considered to be of low sensitivity. This reflects the baseline population profile in section 27.5.3.1 which is characterised as follows:
  - In Norfolk County, North Norfolk, and Breckland the health of people is varied. Life expectancy is higher overall but lower in the most deprived areas, when compared against England averages.
  - The health of people in Broadland District is generally better than the England average.
- Some people would be more sensitive to changes in noise. For this population, sensitivity is considered high. This reflects the site-specific baseline population profile in section 27.5.3.2. Vulnerability in this case is particularly linked to:
  - Living close to sources of noise;
  - Age (both young people and older people);
  - Existing poor health (e.g. Long-term illness);
  - Spending more time in affected dwellings (e.g. Due to low economic activity, home working, shift work, or ill health);
  - Vulnerability due to deprivation or health inequalities; or
  - Having strong views or high degrees of uncertainty about the project (which may be associated with health effects even below thresholds that are generally considered acceptable).

173. The baseline indicates a sub-population more likely to spend extended periods at home due to retirement or long term illness as approximately 25 to 30%. Some populations in North Norfolk and Breckland in the vicinity of the onshore project area are amongst the 30% most deprived neighbourhoods in the England.

174. Under both scenarios the magnitude of the change due to the project can be characterised as **small** (based on the methods described in section 27.3.4.2). This is because construction related noise close to particular dwellings or other community receptors would be infrequent and of short duration (being predominantly limited to periods of passing trench work or vehicle traffic). The levels of noise experienced would be within working noise limits for temporary disruption. At these levels it is unlikely that there would be changes in the risk of developing a new health condition or of exacerbating an existing condition. Reductions in wellbeing associated with short-term, or very short-term, noise levels would be unlikely to persist beyond the period of elevated exposure. The general exposure profile would be one of low exposure by a small population.

175. The significance of the potential effects has been informed by the guide questions in Table 27.4. The following discussion sets out the reasoned conclusions for the professional judgement reached (summarising relevant evidence from section 27.3.4.3):

- Scientific literature does show a causal link between chronic noise above certain thresholds and health determinants. The evidence does not indicate a lower threshold at which health effects do not occur.
- Baseline conditions do show that compared to national comparators the affected population has higher levels of deprivation in the populations around the onshore project area. The populations have a marginally higher level of retirement aged people and a marginally higher level of people with long-term health conditions. This suggests that there is potential for more people to be at home during the day. However, the proportion of children is relatively low by a comparable amount. The baseline does not indicate any special conditions that are likely to amplify noise effects (e.g. due to extreme topography).
- Norfolk County Council's health priorities focus on care for children below five and people who suffer from dementia. Whilst noise is not a key public health priority issue for the County, localised issues are a priority of Norfolk Environmental Health Practitioners', who have legal powers to investigate and control statutory noise nuisance.
- Consultation responses predominantly refer to requirements for the assessment in Chapter 25 Noise and Vibration to comply with relevant standards and undertake appropriate consultation. Chapter 25 Noise and Vibration describes how, with mitigation implemented; residual impacts are assessed as not significant.
- In line with the NPS for Overarching Energy (EN-1) (Department of Energy and Climate Change, 2011c) it can be confirmed that (based on the assessment in Chapter 25 Noise and Vibration) the project has avoided significant impacts for noise and vibration, has proposed mitigation to be put in place where impacts

are predicted, and will put in place measures to effectively manage and control noise.

27.6.3.1.1 Noise effects under Scenario 2

176. The temporal scope for this effect (as described in section 27.4.1.4) varies depending on the area of the project:

- At landfall, there is a short term temporal scope due to the use of HDD and the presence of a temporary onshore works area.
- Along the onshore cable route there is a short term temporal scope because (as described in Chapter 5 Project Description) the onshore cable route will be constructed sequentially. Therefore, any noise will be generated along 150m intervals for approximately one to two weeks before construction moves along the route. The running track will be used during construction between mobilisation areas for up to one or two months at a time due to this sequential nature of the construction. Works are proposed to be undertaken during the day time.
- At the onshore project substation and National Grid substation extension, there is a short term temporal scope because the works are planned across several weeks.
- With regard to traffic noise, there is a medium term temporal scope because this will be a requirement for the entirety of the project. However, locally, the impacts will be short term as the works move along the cable route.

177. The conclusions of Chapter 25 Noise and Vibration can be summarised as follows:

- **Negligible impact** at landfall after mitigation;
- **Negligible impact** along the cable route following the application of mitigation measures;
- **Negligible impact** at the onshore project substation following the application of mitigation measures;
- **Minor adverse** residual impacts due to traffic noise following mitigation at Link 21 that leads to Link 25 near Dereham and Link 69 north of North Walsham; and
- **No impacts** due to vibration.

178. Although three road links (Link 21, Link 25 and Link 69) are identified as receiving a minor adverse impact, their location needs to be put in context. This is because the noise assessment considers the relative change in noise levels at different modelled locations rather than the relative location of receiving populations.

179. Link 21 is the B1147 at Etling Green and Link 25 is Elsing Lane which connects to the B1145. These areas have very few households in proximity and those that are present are agricultural in nature. Therefore, it is assumed that the baseline

environment would include agricultural machinery during certain periods such as harvest that communities would be relatively familiar with. The temporal scope at this location would be very short term (section 27.4.1.4) and there would be a small extent of effect because there is only a small number of people to hear the change. Therefore, there would be a negligible effect on human health for a small number of people.

180. Link 69 is Little London Road that connects Bacton Road with the B1145 north at North Walsham. At the B1145 end there is a hamlet with a small receptor population. At the Bacton Road end there are 5 residencies with a small receptor population. Only the hamlet at the B1145 end would be affected by heavy goods vehicles (HGVs).

181. The Link 69 location has been chosen over alternative routes as the alternatives would affect more people on the outskirts of North Walsham. Mitigation detailed in Chapter 24 Traffic and Transport reduces the number of HGVs per day to 48, which is potentially still a significant increase against baseline. Further mitigation and community engagement could further reduce the impact by, for example, clustering HGV movements to times of least impact to the local community.

182. It should also be noted that the traffic assessment is based on a worst case scenario. Link 69 is between two HDD mobilisation compounds that have been committed to by the project to remove the need for trenched crossing of two other roads. It is possible that at post consent stage, detailed engineering could further reduce the number of HGV movements at this location and there may be potential to employ further mitigation measures. Further details on traffic impacts and proposed mitigation measures are included in the Outline Traffic Management Plan (document reference 8.8) which has been submitted as part of the DCO application.

183. The temporal scope at Link 69 is short term and the extent is small. Although the population size is assumed to be larger than Link 21 and Link 25. With mitigation in place the effect on human health would be negligible.

184. Under Scenario 2 the conclusion of the assessment for population health is that the significance of the effect would be **negligible for the general population** and **minor adverse for vulnerable groups** across the majority of the study area. Vulnerability in this case relates to proximity, carers, young children, retirement aged population, those with long term illness, and those who are unemployed or shift workers who are most likely to spend more of their time at home and who are living adjacent to the project. All effects would be short-term, temporary and would cease on completion of the works. Therefore, there would be no residual long-term health outcome.

27.6.3.1.2 Noise effects under Scenario 1

185. The temporal scope for this effect (section 27.4.1.4) varies depending on the area of the project:

- At landfall, there is a short term temporal scope due to the use of HDD and the construction and presence of a temporary onshore works area.
- Along the cable route there is a very short term temporal scope because (as described in Chapter 5 Project Description) the works on the cable route will be confined only to those areas associated with jointing pit locations (spaced approximately one per circuit per 800m cable). Therefore, any noise emissions will be in the isolated areas for a minimal duration. Works are proposed to be undertaken during the day time.
- At the onshore project substation and National Grid substation extension, there is a short term temporal scope because the works are planned across several weeks.
- With regards traffic noise, there is a short term temporal scope because this will only be a requirement for the construction of the onshore project substation.

186. The conclusions of Chapter 25 Noise and Vibration can be summarised as follows:

- **Negligible impact** at landfall after mitigation;
- **Negligible impact** due to cable pulling and jointing following the application of mitigation measures;
- **Negligible impact** at the onshore project substation following the application of mitigation measures;
- **Minor adverse** residual impacts due to traffic noise following mitigation; and
- **Negligible impact** due to vibration.

187. The minor adverse impacts identified due to traffic noise under this scenario are subject to the same contextual assessment as outlined for Scenario 2 and therefore with mitigation in place the effect on human health would be negligible.

188. Under Scenario 1 the conclusion of the assessment for population health is that the significance of the effect would be **negligible** for the general population and **minor adverse** for vulnerable groups. Vulnerability in this case relates to proximity, carers, young children, retirement aged population, those with long term illness, and those who are unemployed or shift workers who are most likely to spend more of their time at home and who are living adjacent to the project. All effects would be short-term, temporary and would cease on completion of the works. Therefore, there would be no residual long-term health outcome.

27.6.3.2 Air quality effects

189. During construction, there is potential for air quality to be temporarily affected by dust and fine particulate from construction, and emissions from construction vehicles.

190. The population groups relevant to this assessment, due to either proximity or other sensitivities are as defined in section 27.4.1.2:

- The population near landfall (site-specific);
- The population along the onshore cable route (site-specific);
- The population near the onshore project substation and National Grid substation extension (site-specific);
- Children and young people;
- Older people; and
- People with existing poor health (physical and mental health).

191. The key health outcomes relevant to this determinant of health are an increased risk of cardiovascular diseases (Meo and Suraya, 2015) and asthma exacerbation (Orellano et al., 2017).

192. The temporal scope for this effect (as described in section 27.4.1.4) varies depending on the area of the project and scenario. These are discussed below.

193. The conclusions of Chapter 26 Air Quality are outlined in section 27.6.3.2.1 and 27.6.3.2.2 for Scenario 2 and Scenario 1 respectively. The mitigation measures taken into consideration during the assessment are as described in Chapter 26 Air Quality.

194. The potential health effect is considered likely because (based on the methods described in section 27.3.3) there is a plausible source-pathway-receptor relationship:

- Sources of dust are excavated materials and sources of particulate or emissions are construction traffic;
- The pathway is dispersion through the air; and
- Receptors are communities of people.

195. Furthermore, the potential effect is probable as no unusual conditions are required for the source-pathway-receptor linkage.

196. The sensitivity of the general population and vulnerable groups (collectively as a single group) can be characterised as follows (based on the methods described in section 27.3.4.1):

- The sensitivity of the general population is considered to be low because overall health indicators show a healthy population of working age, with a skew

towards an older population. This is discussed in more detail under section 27.6.3.1.

- The sensitivity of vulnerable groups is considered high. This is because there is a marginally higher proportion of households where nobody is in employment, of retirement aged people, and where people have long term illness.

197. The magnitude of the change due to the project can be characterised as low (section 27.3.4.2). For air pollutants that are respirable (e.g. NO_2, PM_{10} and $PM_{2.5}$), the change in air quality close to certain dwellings or other community receptors would be infrequent and of short duration (being predominantly limited to periods of passing trench work or vehicle traffic). The changes would be below all recognised statutory thresholds for health protection. For particles of non-respirable size, coarser (larger and heavier) fractions of dust are expected to rapidly reduce in concentration with distance from source due to precipitation. The potential for nuisance-type dust effects is therefore expected to be occasional and limited. For finer fractions of dust precipitation rates would be slower, affecting a wider area and thus more people. However, exposure is expected to be low due to the finer dust particles dispersing (reducing in concentration) with increased distance. At these levels it is unlikely that there would be changes in the risk of developing a new health condition or of exacerbating an existing condition. Given the semi-rural context (where baseline air quality is generally good) it is unlikely that there would be a significant change in population health outcomes for the neighbouring community during these periods.

198. The significance of the potential effects has been informed by the guide questions in section 27.3.4. The following discussion sets out the reasoned conclusions for the professional judgement reached (summarising relevant evidence from section 27.3.4.3):

- Scientific literature does indicate a causal link between air pollution due to dust, particulate, and various gases, including those associated with internal combustion engines with health impacts. Whilst the literature supports there being thresholds set for health protection purposes, it also acknowledges that for some air pollutants there are non-threshold health effects (i.e. when there is no known exposure threshold level below which adverse health effects may not occur). The assessment has identified population groups that may be particularly sensitive to air quality effects. The assessment in Chapter 26 Air Quality shows that the concentration of pollutants is not likely to exceed thresholds set for health protection (i.e. UK AQOs).
- Baseline conditions show that there is a marginally higher proportion of people that are likely to be at home, i.e. closer to the construction area, for more of the day.

- These populations align with the Health Priority areas of Norfolk County Council who have a particular focus on older age people and people suffering from long term illness.
- Consultation responses request that the air quality assessment is agreed with appropriate stakeholders. Chapter 26 Air Quality confirms that this assessment has been agreed.
- The air quality assessment is summarised above and indicates that with mitigation and control measures implemented the onshore construction works would be within statutory requirements (UK AQOs) and would be unlikely to result in nuisance from widespread dust deposition. The assessment undertaken in Chapter 26 Air Quality follows regulatory guidance as required in the UK.
- The NPS for Overarching Energy (EN-1) (Department of Energy and Climate Change, 2011c) does require projects to consider air pollution, which has been undertaken, but notes that projects with significantly detrimental impacts on health are subject to separate regulations.

27.6.3.2.1 Air quality effects under Scenario 2

199. The temporal scope for this effect (as described in section 27.4.1.4) varies depending on the area of the project:

- At landfall, there is a short term temporal scope due to long HDD and the presence of the landfall compound.
- Along the cable route there is a very short term temporal scope because (as described in Chapter 5 Project Description) the cable route will be constructed sequentially. Therefore, any dust or emissions will be generated along 150m intervals for approximately one to two weeks before moving along the route. Works are proposed to be undertaken during the day time.
- At the onshore project substation, there is a short term temporal scope because the works are planned across several months.
- With regard to traffic emissions, there is a medium term temporal scope because this will be a requirement throughout the whole construction phase of the project. However, locally, the impacts will be short term as the works move along the cable route.

200. Chapter 26 Air Quality concludes that there is a low risk to human health due to dust and fine particulate arising from earthwork, construction, and temporary tracking. Following implementation of mitigation measures recommended in the chapter residual impacts are not expected to be significant.

201. The conclusions of Chapter 26 Air Quality due to construction vehicle emissions are:

- Predicted negligible impacts at all receptor locations except one, which was predicted to experience a ‘slight adverse’ impact;

- Predicted pollutant concentrations were below the relevant air quality objectives at all considered receptor locations; and
- Project-generated construction traffic was not predicted to cause a breach of any of the air quality objectives at any identified sensitive receptor location.

202. The 'slight adverse' impact is at location R71 which is south east of Norwich and is on the junction of the Norwich Southern Bypass and the Ring Road. The effect is due to annual mean NO_2 concentrations which are high at this point comparative to the average for Norfolk. The change is 30.90 to 31.63µg.m^{-3} which equates to a 2% increase over baseline which is considered a negligible change with regard to human health.

203. Under Scenario 2 the conclusion of the assessment for population health is that the significance of the effect would be **negligible for the general population** and **minor adverse for vulnerable groups**. Vulnerability in this case relates to, carers, young children, retirement aged population, those with long term illness, and those who are unemployed or shift workers who are most likely to spend more of their time at home and who are living adjacent to the project. All effects would be short-term, temporary and would cease on completion of the works. Therefore, there would be no residual long-term health outcome.

27.6.3.2.2 Air quality effects under Scenario 1

204. The temporal scope for this effect (as described in section 27.4.1.4) varies depending on the area of the project:

- At landfall, there is a short term temporal scope due to the use of HDD and the presence of the landfall compound.
- Along the cable route there is a very short term temporal scope because (as described in Chapter 5 Project Description) the works on the cable route will be confined to those associated with jointing pit locations. Therefore, any dust or emissions will be generated in the isolated area for a minimal duration. Works are proposed to be undertaken during the day time.
- At the onshore project substation, there is a short term temporal scope because the works are planned across several months.
- With regard to traffic emissions, there is a medium term temporal scope because this will be a requirement for the entirety of the project. However, locally, the impacts will be short term as the works move along the cable route.

205. Chapter 26 Air Quality concludes that there is negligible risk to human health due to dust and fine particulate arising from earthworks and construction. There is also a low risk due to emissions generated by construction vehicles running along temporary tracking. Following implementation of mitigation measures as outlined in

the chapter and in the outline CoCP (document reference 8.1), residual impacts are not expected to be significant.

206. The conclusions of Chapter 26 Air Quality due to construction vehicle emissions are:

- A predicted negligible impact at all receptor locations;
- Predicted pollutant concentrations were below the relevant air quality objectives at all considered receptor locations; and
- Project-generated construction traffic was not predicted to cause a breach of any of the air quality objectives at any identified sensitive receptor location.

207. Under Scenario 1 the conclusion of the assessment for population health is that the significance of the effect would be **negligible for the general population** and **minor adverse for vulnerable groups**. Vulnerability in this case relates to, carers, young children, retirement aged population, those with long term illness, and those who are unemployed or shift workers who are most likely to spend more of their time at home and who are living adjacent to the project. All effects would be short-term, temporary and would cease on completion of the works. Therefore, there would be no residual long-term health outcome.

27.6.3.3 Ground and / or water contamination effects

208. During construction, water quality has the potential to be affected by the accidental release of potentially polluting substances or mobilisation of existing contamination as a result of intrusive works such as excavation of soils, piling at the onshore project substation or trenchless drilling techniques. Drinking water is not likely to be affected because the population of Norfolk is supplied by piped drinking water and do not abstract water directly from surface or ground water sources without treatment.

209. The population groups relevant to this assessment, due to either proximity or other sensitivity are (as defined in section 27.4.1.2):

- The population near landfall (site-specific);
- The population along the onshore cable route (site-specific);
- The population near the onshore project substation (site-specific);
- Children and young people;
- Older people; and
- People with existing poor health (physical and mental health).

210. The key health outcomes relevant to this determinant of health relate to potential toxicological exposure associated with contaminated bathing water. Effects may relate to either biological or chemical contaminants. Potential examples of contaminant pathways include accidental spillage from site amenities (i.e. biological contaminants); accidental spillage from machinery or construction processes (i.e.

chemical contaminants); or exposure of buried contaminants (e.g. from contaminated soil).

211. The temporal scope for this effect (as described in section 27.4.1.4) varies depending on the area of the project and scenario. These are discussed below.

212. The conclusions of Chapter 20 Water Resources and Flood Risk and Chapter 19 Ground Conditions and Contamination are outlined in 27.6.3.3.1 and 27.6.3.3.2 for Scenario 2 and Scenario 1 respectively.

213. Based on the methods described in section 27.3.4 there is a plausible but unlikely source-pathway-receptor relationship:

- Sources include the potential for increased water turbidity, accidental fuel spill, or mobilisation of historic contamination;
- The pathway would be mobilisation or remobilisation of contaminants into bathing waters; and
- Receptors include users of the beach at landfall and users of watercourses.

214. The plausibility of the potential effect occurring largely depends on unusual conditions to make the source-pathway-receptor linkage. Other than increased water turbidity (which has limited potential to affect health), the sources relate to accidental releases of pollutants or the unexpected encountering of historic contamination. Mitigation measures are described in Chapter 20 Water Resources and Flood Risk and Chapter 19 Ground Conditions and Contamination to reduce the probability of a risk occurring in the first place and should it occur, further mitigation to reduce the risk of widespread contamination that could affect the public.

215. The sensitivity of the general population and vulnerable groups (collectively as a single group) can be characterised as follows (based on the methods described in section 27.3.4.1);

- The general population and vulnerable groups are considered to be of low sensitivity. This reflects the limited likelihood that people would interact with bodies of water for recreational purposes.

216. Vulnerability in this case is particularly linked to: age (both young people and older people); and existing poor health (e.g. long-term illness). It also particularly relates to disruption in the unlikely event of a serious contamination event that may require bathing waters to be temporally closed or temporary use of alternative emergency water sources.

217. The magnitude of the change due to the project can be characterised as very low (based on the methods described in section 27.3.4.2). With regard to coastal or fluvial bathing waters, any change in water quality would be expected to rapidly

reduce in concentration with distance from source due to dispersion. Any increased turbidity in coastal water associated with the landfall HDD method would be transitory and temporary and unlikely to affect the bathing water quality to the extent of deterring swimmers or other recreational water users. Furthermore, the likelihood of the effect pathway would reduce outside of the main recreational seasons. The marine activities would mitigate against, and monitor for, any spills or historic contamination as described in Chapter 9 Marine Water and Sediment Quality. The general water related pollutant exposure profile would be one of low exposure (if any) to a small population.

218. The significance of the potential effects has been informed by the guide questions in 27.3.4. The following discussion sets out the reasoned conclusions for the professional judgement reached (summarising relevant evidence from section 27.3.4.3):

- Scientific literature indicates sufficient strength of evidence from sufficiently high-quality scientific studies to establish that clean and sufficient drinking water is required to remain healthy. Children may be particularly sensitive to toxicological effects due to developmental stage and more time spent outdoors, including use of bathing waters. The baseline indicates that the areas affected by the project typically have a lower than average percentage of young people (compared to national comparators) and lower population density (compared to national comparators).
- Whilst a review of regional public health needs assessments and strategies indicates that water quality, as a determinant of health, is not a key public health priority issue, health priorities for Norfolk County Council do focus on young people generally.
- The Chapter 20 Water Resources and Flood Risk and Chapter 19 Ground Conditions and Contamination results indicate that the risks for population health are likely to be negligible. At points such as crossing of small scale water courses, the public would not have access to any impounded water.

27.6.3.3.1 Ground and / or water contamination effects under Scenario 2

219. The temporal scope for these effects is (section 27.4.1.4) would be short term due to the short term duration of the different elements of construction.

220. The conclusions of Chapter 20 Water Resources and Flood Risk and Chapter 19 Ground Conditions and Contamination can be summarised as follows:

- The impact assessment identified potential impacts upon water quality (that are not drinking water sources) during construction of the project, of which impacts were assessed to vary from negligible to minor adverse, depending upon the receptor. Where impacts have been assessed as minor, this is due to the

heightened sensitivity or value of the receptor, for example as a result of international and national nature conservation designation status associated with a water body or due to a water body being classified as having Good Ecological Potential under the Water Framework Directive.

- Following implementation of mitigation measures to prevent pollution of groundwater, the project is predicted to have only negligible to minor adverse effects in relation to water quality.

221. The conclusion of the assessment for population health is that the significance of the effect would be **negligible for the general population** and **negligible for vulnerable groups**. Vulnerability in this case may particularly relate to disruption in the unlikely event of a serious contamination event that may require bathing waters to be temporally closed or temporary use of alternative emergency water sources. All effects would be short-term, temporary and would cease on completion of the works. Therefore, there would be no residual long-term health outcome.

27.6.3.3.2 Ground and / or water contamination effects under Scenario 1

222. As described under Scenario 2 , the temporal scope for these effect is (as described in section 27.4.1.4) short term.

223. The conclusions of Chapter 20 Water Resources and Flood Risk and Chapter 19 Ground Conditions and Contamination are the same as those outlined under Scenario 2 (section 27.6.3.3.1).

224. The conclusion of the assessment for population health is that the significance of the effect would be **negligible for the general population** and **negligible for vulnerable groups**. All effects would be short-term, temporary and would cease on completion of the works. Therefore, there would be no residual long-term health outcome.

27.6.3.4 Physical activity effects

225. During construction, there is the potential for physical activity to be temporarily affected by the project temporarily diverting Public Rights of Way (PRoWs). All other interaction with public spaces such as playing fields and common land has been avoided through site selection as part of the embedded mitigation for the project.

226. The population groups relevant to this assessment, due to either proximity or other sensitivity (as defined in section 27.4.1.2) are:

- The population near landfall (site-specific);
- The population along the onshore cable route (site-specific);
- The population near the onshore project substation (site-specific);
- Children and young people;
- Older people;
- People with existing poor health (physical and mental health).

227. The key health outcomes relevant to this determinant of health are physical health conditions (e.g. cardiovascular health) and mental health conditions (e.g. stress, anxiety or depression) associated with levels of physical activity and obesity levels. For example due to the level of active travel (such as road cycling), leisure activities (such as team sports on public facilities) or outdoor activities (such as hiking or mountain biking). Disruption due to construction and the temporary re-routing of access and PROWs may affect the attractiveness and availability of recreational assets.

228. The temporal scope for this effect (as described in section 27.4.1.4) varies depending on the area of the project and scenario. These are discussed in sections 27.6.3.4.1 and 27.6.3.4.2 for Scenario 2 and Scenario 1 respectively.

229. The potential effect is considered per scenario for outdoor activities (based on the methods described in section 27.3.4).

230. The mitigation measures taken into consideration during the assessment are as described in Chapter 30 Tourism and Recreation and Chapter 31 Socio-economics. Disturbance of people using space near the construction site are mitigated through the measures described in section 27.6.3.1 Noise effects and section 27.6.3.1.1 Air Quality effects. Any alternative routes and management practices of PRoW impacts would be agreed with Norfolk County Council prior to construction in accordance with the Public Rights of Way Strategy (document reference 8.4) and outline COCP (document reference 8.1).

231. The sensitivity of the general population and vulnerable groups (collectively as a single group) can be characterised as follows (based on the methods described in section 27.3.4.1):

- The general population is considered to be of medium sensitivity. This reflects the site-specific baseline population profile in section 27.5.3. This indicates that on some measures the population is less healthy and more deprived than national comparators. Physical activity is known to be an important factor for many health and quality of life outcomes.
- Some people would be more sensitive to changes in physical activity. For this population, sensitivity is considered high. Vulnerability in this case is particularly linked to people who are less able to adapt to changes and who have limited access to alternatives (e.g. walking routes with a tranquil setting). These people may undertake less exercise during the period that they are affected by active project works and therefore forgo the benefits to physical and mental health. Young or older people may have higher levels of dependence on carers or public transport to access alternative physical activity opportunities. People (adults and

children) who are already overweight or obese would be particularly sensitive to fewer opportunities to be physically active.

232. The significance of the potential effects has been informed by the guide questions in section 27.3.4. The following discussion sets out the reasoned conclusions for the professional judgement reached (summarising relevant evidence from section 27.3.4.3):

- Scientific evidence draws a strong link between levels of physical activity and physical and mental health outcomes. The evidence also indicates that nearly half of people aged over 60 years may be inactive.
- The representative baseline of neighbourhoods around the landfall, onshore cable route, and onshore project substation report a marginally lower level of very good or good health and daily activity level compared to the average for England. This reflects the marginally higher proportion of people aged over 60. However, all representative neighbourhoods show a lower level of childhood obesity than the average for England. There is also marginally fewer children as a proportion of the population.
- Norfolk County Council key health priorities include obesity reduction, improvements in mental health and creating a healthier physical environment. However, there are no consultation responses with regard to impacts on physical activity. There are also no regulatory standards regarding physical activity.

27.6.3.4.1 Physical activity effects under Scenario 2

233. No PRoWs are located at the onshore project substation or the National Grid substation extension. Therefore, the impacts associated with construction works are limited to the landfall and onshore cable route only. The use of long HDD at landfall under both scenarios will result in no need to close either the Norfolk Coastal Path or the beach at Happisburgh.

234. There is the potential for physical activity to be temporarily affected by the project temporarily diverting PRoW during duct installation and cable pulling activities along the cable route.

235. The temporal scope for these effects is (section 27.4.1.4) very short term. This is because the onshore cable route does not directly impact any community infrastructure (such as sports facilities) as described in Chapter 31 Socio-economics. However, temporary and reversible impacts to PRoW and coastal waters are discussed in Chapter 30 Tourism and Recreation. During these periods there would be a change in the tranquillity and perceived quality of physical activity opportunities.

236. The conclusions of these chapters can be summarised as follows, assuming mitigation is implemented:

- There is no residual impact on community infrastructure (such as sports facilities) due to site selection avoiding interaction with these sites;
- The residual impact on PRoWs is expected to be of negligible significance.

237. The potential effect is considered likely for outdoor activities (based on the methods described in section 27.3.4) but not for sports activities using community infrastructure. This is because there is a plausible source-pathway-receptor relationship between the onshore project and PRoWs but not for community infrastructure:

- The source is construction works on the onshore cable route and vehicles/plant operations increasing emissions and disturbance on the PRoW;
- The pathway is the perceived change in the usability of the PRoW and
- Receptors are users of the PRoW, resulting in a lower level of active travel or outdoor recreation.

238. The effects would be due to the sequential duct installation along the onshore cable route. Approximately 150m of duct will be installed over one to two weeks and during this time any PRoW would be temporarily diverted for approximately one to two weeks. After this, the site would be reinstated except for the temporary running track which would have a controlled crossing until the cable route between the mobilisation areas had been completed. The area would then be reinstated but some time would be required before the same level of natural coverage (such as grass, shrubs, and hedgerows) returns.

239. The installation of the cable within the ducts will require cable pulling works at jointing pits located along the cable route. The locations of the jointing pits are yet to be determined but will be chosen based on site selection to avoid sensitive features, including the presence of PRoW, wherever possible and engineering considerations. Parts of the running track will also be retained or reinstalled to facilitate access to the jointing pits locations and therefore could potentially interact with PRoW. Therefore, as a worst case it is assumed there will be a requirement for temporary diversions and controlled crossing to be in place during cable pulling works as outlined above at a limited number of locations.

240. The magnitude of the change due to the project can be characterised as low (based on the methods described in section 27.3.4.2). The reduction in the quality of the environment would be temporary, reversible, and localised. Temporary diversions may marginally increase the length of a PRoW, which may disincentivise use by some people. However, the temporary diversions would be unlikely to affect population physical activity levels to the extent of changes in the risk of developing new health

conditions or of exacerbating existing conditions. Any short-term changes in physical activity levels would be unlikely to have a lasting influence on population health.

241. The conclusion of the assessment for population health is that any changes in health outcomes associated with disruption of, or reduced environmental quality (noise, dust, air quality and views) along PRoW would be **negligible for the general population** and **negligible for vulnerable groups.** This is because the only direct impact on access of physical activity would be in relation to diversion of PRoW which are temporary, localised, and reversible. Vulnerability in this case relates to people who currently make frequent use of the routes primarily due to their current tranquillity and for whom there are access barriers to alternate routes in the area. People over the age of 60 and those with existing health conditions may particularly benefit from physical activity, so would also be particularly sensitive to any change. All effects would be short-term, temporary and would cease on completion of the works. Therefore, there would be no residual long-term health outcome.

27.6.3.4.2 Physical activity effects under Scenario 1

242. The potential effects under this scenario are limited to the cable pulling activities. As outlined above (paragraph 239) interactions with PRoW could occur at jointing pit locations and in areas where the running track is re-installed. However, will be avoided as much as reasonably possible during detailed design.

243. As outlined for Scenario 2, there is no potential for impact at landfall, at the onshore project substation or the National Grid substation extension.

244. The potential effect is considered plausible for outdoor activities (based on the methods described in section 27.3.4). This is because there is a plausible source-pathway-receptor relationship between the onshore project and PRoW but not for community infrastructure:

- The source is cable pulling works and vehicles/plant operations increasing emissions and disturbance on the PRoWs;
- The pathway is the perceived change in the usability of the PRoW and
- Receptors are users of the PRoWs, resulting in a lower level of active travel or outdoor recreation.

245. The magnitude of the change due to the project can be characterised as low (in section 27.3.4.2).

246. For the same reasons as outlined under Scenario 2; the conclusion of the assessment for population health is that any changes in health outcomes associated with disruption of, or reduced environmental quality (noise, dust, air quality and views)

along PRoWs would be **negligible for the general population** and **negligible for vulnerable groups.**

27.6.3.5 Journey times and / or reduced access effects

247. During construction, there is the potential for journey times and access to be temporarily affected by an increase in the number of HGVs or employee vehicles on the road and temporary traffic management at certain locations. These have the potential to lead to temporary delays and temporarily reduce access to local services.

248. The population groups relevant to this assessment, due to either proximity or other sensitivity are (as defined in section 27.4.1.2):

- The population of North Norfolk, Broadland and Breckland Districts (local);
- People living in deprivation, including those on low incomes; and
- People with existing poor health (physical and mental health).

249. Vulnerability in this case relates to people living in deprived areas in the vicinity of the landfall, onshore cable route, and onshore project substation, particularly people with long-term illnesses (and their carers) and users of ambulance services.

250. Travelling to, or accessing health care, underpins management of illness or injury. The key health outcomes relevant to this determinant of health are emergency response times or non-emergency treatment outcomes associated with delays or non-attendance caused by increased traffic and journey times arising from additional project traffic.

251. The temporal scope for this effect (as described in section 27.4.1.4) varies depending on the area of the project and scenario. The conclusions of Chapter 24 Traffic and Transport are summarised in sections 27.6.3.5.1 and 27.6.3.5.2 for Scenario 2 and Scenario 1 respectively.

252. General mitigation measures taken into consideration for traffic and transport impacts are detailed in Chapter 24 Traffic and Transport. Traffic impacts during construction will be managed through a Traffic Management Plan, Travel Plan and Access Management Plan. Outline version of these documents including proposed mitigation measures have been submitted as part of the DCO application (Document references 8.8, 8.9 and 8.10).

253. The potential effect is considered likely because (based on the methods described in section 27.3.4) this is a potential source-pathway-impact relationship as follows:

- The source relates to an increased number of vehicles on the road network or temporary traffic management measures due to the project;

- The pathway is journey times or accessibility to amenities/services, particularly healthcare (emergency and non-emergency); and
- The receptor is local road users.

254. Furthermore, the potential effect is probable as no unusual conditions are required for the source-pathway-receptor linkage.

255. The sensitivity of the general population and vulnerable groups (collectively as a single group) can be characterised as follows (based on the methods described in section 27.3.4.1):

- The sensitivity of the general population is considered to be low because journey times to work are similar to the average in England and the population is considered to be in generally good health hence requiring fewer visits to primary health care. Furthermore, as part of embedded mitigation for the project developed through the site selection process, the project has avoided built up areas and locations where health care facilities are located.
- A small number of vulnerable communities may be affected more than the general population. The sensitivity of vulnerable groups is considered high because deprivation indices (section 27.5.3.1) show some neighbourhoods around the landfall, onshore cable route, and the onshore project substation are ranked between 23 and 44 out of 326 in England (1 being the most deprived). Deprived populations may already face more access barriers than the general population and therefore be more sensitive to access changes. The more sensitive population particularly includes those accessing health services (emergency or non-emergency) at times and locations where there may be some increase in congestion. Ambulance services (and the recipients of their care) are particularly sensitive to delays.

256. The significance of the potential effects has been informed by the guide questions in 27.3.4. The following discussion sets out the reasoned conclusions for the professional judgement reached (summarising relevant evidence from section 27.3.4.3):

- Scientific literature shows an association between access and healthcare outcomes. The evidence base shows a correlation between areas with greater access to primary health care and lower hospitalization rates for ambulatory care sensitive conditions (conditions which are potentially avoidable by well-functioning primary care) (Rosano et al., 2013).
- Transportation barriers to health care access are common, and greater for vulnerable populations. Patients with a lower socio-economic status have higher rates of transportation barriers to ongoing health care access than those with a

higher socio-economic status. Transportation barriers can also affect access to pharmacies and thus medication adherence. (Syed et al., 2013)

- Baseline conditions show that some communities in the vicinity of the onshore project area may have a lower socio-economic status and therefore face higher rates of transportation barriers.
- Although transportation is not a specific health priority of the Norfolk County Council it underpins other health priorities such as support to children under the age of 5, and support to carers of the long term ill such as older people with dementia.
- The only consultation response with regards journey times to primary health care is from NHS England who request an analysis of the likely increase in demand for services as a result of the project. Chapter 31 Socio-economics has undertaken an assessment of labour demand and shows that the project will have a minor beneficial impact on job creation. Staff employed in construction of the onshore element of the project are likely to be of working age and in good health. It is therefore unlikely that this would lead to an increased demand on health services because those that are recruited locally would maintain their local GP and it is expected that those who are recruited from outside of Norfolk would be distributed across the New Anglia Local Enterprise Partnership (LEP) region.
- There are no regulatory standards with regard to impacts on journey times. The Department of Health target is that the ambulance service reaches 75% of life-threatening calls within eight minutes. The East of England Ambulance Service NHS Trust already faces challenges in meeting this target[15].
- The NPS for Overarching Energy (EN-1) (Department of Energy and Climate Change, 2011c) mirrors NHS England's consultancy response with regards a need to determine if the change in population would increase demand on local services.

27.6.3.5.1 Journey times and / or reduced access effects under Scenario 2

257. Under Scenario 2, the temporal scope for these effects is (as described in section 27.4.1.4) as follows:

- With regard to delays due to traffic management along routes:
  - At landfall, there is a short term temporal scope due to HDD and presence of a temporary onshore works area.

[15] NHS England. Ambulance Quality Indicators. Accessed April 2018. http://www.ambulancestats.co.uk/presentation.php#1 and https://www.england.nhs.uk/statistics/statistical-work-areas/ambulance-quality-indicators/

  - Along the onshore cable route there is a very short term temporal scope because (as described in Chapter 5 Project Description) the cable route will be constructed sequentially.
  - At the onshore project substation and National Grid substation extension, there is a short term temporal scope because the works are planned across several weeks.

- With regard to traffic movement, the temporal scope would also be short term. Although the project as a whole has a medium term (measured in years) temporal scope, for areas where impacts are predicted in Chapter 24 Traffic and Transport, the duration is measured in weeks.

258. Chapter 24 Traffic and Transport concludes that the residual magnitude of driver delay impacts is low however, through consultation, has identified that some of the junctions assessed (mainly on to the A47) have a high sensitivity because they form part of the Strategic Road Network. The traffic assessment includes an assessment of driver delays and concludes that the impact would be minor.

259. The magnitude of the change due to the project can be characterised as low based on the following (section 27.3.4.2):

- Only small changes in journey times would be expected, largely relating to short delays at certain junctions;
- The frequency of any delays is likely to be low because works are sequential and delays would be temporary. Any change is considered unlikely to be of a scale that would affect quality of life or receipt of time-critical healthcare;
- Any change in journey times would be reversible as the project does not make any permanent change to the road network; and
- Although a large number of people use the road network and therefore may be affected, the change experienced by individuals and local communities is expected to be small. Thus the general exposure profile would be one of low exposure to a large population.

260. The conclusion of the assessment for population health is that the significance of the effect would be **negligible for the general population** and **minor adverse for vulnerable groups**. Vulnerability in this case relates to people who are more likely to require urgent medical care and/or are required to make frequent use of the road networks primarily due to medical access needs and those who require at home medical assistance. People over the age of 60 and those with existing health conditions would be particularly sensitive to any change. All effects would be short-term, temporary and would cease on completion of the works. Therefore, there would be no residual long-term health outcome.

27.6.3.5.2 Journey times and / or reduced access effects under Scenario 1

261. There is potential for effects at landfall, during cable pulling works and the construction of the onshore project substation and the National Grid substation extension.

262. The assessment under Scenario 1 follows that of Scenario 2 as the temporal scope for the effects are the same. Despite there being less construction works required along the cable route under Scenario 1, the temporal scope for effects will be at worst short term and the highly sensitive junctions as identified in Chapter 24 Traffic and Transport may also be impacted under Scenario 1 (as the jointing pits and access locations have not yet been defined).

263. The conclusion of the assessment for population health is that the significance of the effect would be **negligible for the general population** and **minor adverse for vulnerable groups**.

27.6.4 Potential Effects during Construction and Operation

27.6.4.1 Employment (Scenario 1 and Scenario 2)

264. Employment has been considered across both construction and operation; as discussed in Chapter 31 Socio-economics, the development of the project is part of a wider process of developing an offshore wind supply chain in the New Anglia LEP region. Therefore, from a human health perspective, creating a demand for transferable skills (both between construction projects and on to operation of projects) has a multiplying effect on employment. Direct employment by the project also creates indirect employment in the supply chain and induced employment due to expenditure.

265. The population groups and temporal scope are the same under both scenarios therefore both scenarios are considered to have the same potential effects on employment.

266. The population groups relevant to this assessment, due to either proximity or other sensitivity are (as defined in section 27.4.1):

- The population of Norfolk County (regional); and
- People living in deprivation, including those on low incomes.

267. The key health outcomes relevant to this determinant of health are indirect influences on physical health (e.g. cardiovascular conditions) and mental health conditions (e.g. stress, anxiety or depression) due to improvements in social determinants, such as improved socio-economic position, greater job security and facilitating beneficial lifestyle choices (e.g. healthier eating and recreational physical activity, including for dependants).

268. The temporal scope for these effects (section 27.4.1.4) is variable:

- During construction, the temporal effect is measured in years but individuals may only be directly employed for months at a time. However, the overall effect on direct and indirect employment would be considered across the duration of the construction phase and is therefore medium term;
- During operation, it is expected that people would be permanently employed and that this employment could last for decades. Therefore the temporal scope is long term.

269. The conclusions of Chapter 31 Socio-economics assessed that employment had a minor beneficial impact on the labour market of the New Anglia LEP. However, the cumulative impact of developing the New Anglia LEP as a hub for offshore wind would have moderate long term benefits with the potential of creating major benefits if appropriate training and supply chain development is undertaken across the different offshore wind projects in operation, construction or development off the coast of the New Anglian LEP.

270. The enhancement measures taken into consideration during the assessment are the positive engagement that Norfolk Boreas Limited is undertaking with local supply chain companies and the New Anglia LEP.

271. The potential effect is considered likely because (based on the methods described in section 27.3.4) there is a potential source-pathway-impact relationship:

- The source is direct and indirect job creation due to the development of the project;
- The pathway is through employment, with increased probability of effect due to supply chain and skills development being undertaken by Norfolk Boreas Limited;
- The receptor is people of working age in the regional labour market (and their dependants).

272. The sensitivity of the general population and for vulnerable groups (collectively as a single group) can be characterised as follows (section 27.3.4.1). Sensitivity in this case is related to how likely it is a population could benefit from being employed:

- Most people in the region are already in stable employment that would not be affected by the project (or are a dependant of such a person). The regional population also has below average income deprivation compared to national comparators. However, as described in Chapter 31 Socio-economics, education deprivation is relatively high compared to the rest of England. People with a lower educational attainment may find it harder to gain employment in

technical areas required by the offshore wind industry. The sensitivity of the general population is therefore considered to be medium.

- For some groups, there is the potential for high levels of sensitivity. Vulnerable populations include young people choosing their careers, people on low incomes or who are unemployed and future young or older people who may rely on those employed by the project.

273. The magnitude of the change due to the project can be characterised as follows (section 27.3.4.2). There would be direct and indirect employment opportunities both during construction and during operation. Construction jobs would be short- to medium- term, but include upskilling that would have longer term benefits. Operational jobs could provide several decades (around 30 years) of benefit to those employed and their dependants. The majority of the jobs are expected to be drawn from the regional level, providing benefits to those employed as well as their dependants. Compared to national comparators, the higher proportion of retired people (and lower proportion of young people) close to the actual project sites suggests that fewer direct economic benefits would be experienced in these areas.

274. The project's relatively small contribution to direct employment (as a proportion of the regional labour market) suggests the change, whilst positive, is unlikely to be associated with a widespread reduction in inequalities or a widespread increase in prosperity or quality of life. The magnitude (from the health perspective) is considered positive but low, driven by the longer term regional benefits to upskilling and employment.

275. The significance of the potential effects has been informed by the guide questions in Table 27.4. The following discussion sets out the reasoned conclusions for the professional judgement reached (summarising relevant evidence from section 27.3.4.3):

- Scientific literature shows that good quality employment is generally associated with better health. Employment can have a protective effect on depression and general mental health (van der Noordt et al., 2014). Unemployment may occur due to poor health, it may also cause poor health (Herbig et al., 2013).
- The baseline shows that the labour market in the New Anglia region is relatively strong. Although the average income deprivation is lower than the national average there are more deprived areas close to the landfall, onshore cable route, and onshore project substation that may struggle to benefit from employment opportunities.
- There were no relevant consultation responses with regard to employment as a determinant of health. However, comments relating to increased demand on local services or changes to population size are related to potential in-migration due to employment opportunity. These have been considered in Chapter 31

Socio-economics which also finds that the level of in-migration would not be significant in relation to the size of the population.

- There are no regulatory standards with regard to employment as a determinant of health.
- The NPS for Overarching Energy (EN-1) (Department of Energy and Climate Change, 2011c) recommends "*considering the potential effects, including benefits, of a proposal for a project, the IPC will find it helpful if the applicant sets out information on the likely significant social and economic effects of the development, and shows how any likely significant negative effects would be avoided or mitigated. This information could include matters such as employment, equality, community cohesion and well-being*." These effects have been considered between this chapter, Chapter 30 Tourism & Recreation, and Chapter 31 Socio-economics.

276. The conclusion of the assessment for population health is that the significance of the effect would be **negligible for the general population** and **minor beneficial for vulnerable groups.** Vulnerability in this case relates to direct and indirect employment opportunities for people living in deprivation or who are of working age (including their dependants).

27.6.5 Potential Effects during Operation

277. Under both scenarios the onshore project substation would be both constructed and operated by Norfolk Boreas. The difference in location is marginal and would therefore not affect the source pathway receptor model for human health effects with regard to noise or EMF, which are the two potential sources that could have an effect on human health during operation of the onshore project substation. Therefore, during operation, both scenarios are considered to have the same effects on human health.

27.6.5.1 Noise (Scenario 1 and Scenario 2)

278. The potential for noise impacts during operation of the onshore project substation has been considered under both scenarios in Chapter 25 Noise and Vibration.

279. The population groups relevant to this assessment, due to either proximity or other sensitivity are (as defined in section 27.3):

- The population near the onshore project substation (site-specific) including the following vulnerable groups;
  - Children and young people;
  - Older people;
  - People with existing poor health (physical and mental health); and
  - People living in deprivation, including those on low incomes.

280. The key health outcomes are the same as those discussed in section 27.6.3.1 in relation to construction noise effects.

281. The temporal scope for this effect is (as described in section 27.4.1.4) long term as it relates to the operational phase of the project.

282. Against the background noise level, Chapter 25 Onshore Noise and Vibration found that with mitigation and under both scenarios:

- all receptor locations would not be impacted by noise; and
- all receptor locations noise level contributions would be in the range of 20dB (equivalent to rustling of leaves)[16] to 30dB (equivalent to a quiet rural area)[13].

283. The mitigation measures taken into consideration during the assessment are described in Chapter 25 Onshore Noise and Vibration. Norfolk Boreas Limited are committed to providing a final design of the project which will meet the standards of low noise emissions expected by both the UK regulatory bodies. Noise reduction technology and design approach is discussed within the assessment and there are many proven mitigation options that, through the detailed design process, can be combined to create a design that will comfortably meet the required low noise emissions, resulting in no impact magnitude in accordance with BS4142:2014.

284. Based on the methods described in section 27.4.1.4 there is not a plausible source-pathway-receptor relationship:

- Following implementation of the mitigation measures outlined in Chapter 25 section 25.8.6.2 there would be no impact magnitude resulting in negligible impact from noise arising from the onshore project substation.
- Therefore, the pathway that existed would be removed following implementation of mitigation; and
- Due to this, there would be no impact from noise from the onshore project substation.

285. The above assessment is applicable to both scenarios. Therefore, there will be **no impact** in relation to noise following the mitigation measures as outlined in Chapter 25 Noise and Vibration.

27.6.5.2 Electromagnetic fields (EMF) (Scenario 1 and Scenario 2)

286. Throughout the operational period, EMF effects may arise from the operation of the onshore project substation and National Grid substation extension, also along the onshore cable route including location where the cable route crosses with the underground cables of Hornsea Project Three. Further information about EMF of

[16] IAC Acoustics, 2018, Comparitive Examples of Noise Levels. Available at: http://www.industrialnoisecontrol.com/comparative-noise-examples.htm

Norfolk Boreas's infrastructure and where it interacts with Hornsea Project Three's cable route can be found on the Norfolk Boreas Limited website[17 and 18].

287. The population groups relevant to this assessment, due to either proximity or other sensitivity are (as defined in section 27.3.4):

- The population near the onshore project substation (site-specific); and
- The population along the cable route including the following vulnerable groups;
  - Children and young people;
  - Older people;
  - People with existing poor health (physical and mental health); and
  - People living in deprivation, including those on low incomes.

288. Norfolk Boreas Limited's policy is to only design and install equipment that is compliant with the relevant exposure limits. To ensure this, all of the equipment for the project capable of producing EMFs has been assessed in accordance with the provisions of the Government's Code of Practice on Compliance, which is compliant with ICNIRP guidance. Therefore, there is very limited potential for changes in physical health due to EMF exposure.

289. The temporal scope for potential effects would be likely to be long term due to the operational phase lasting decades.

290. EMF effects have been analysed by the National Grid on behalf of Norfolk Boreas Limited. These effects have been analysed for the general operation of the projects as well as with a focus on the point at which the Norfolk Boreas and Hornsea Project Three cable routes will cross.

291. Table 27.24[8] shows the general magnetic fields of the HVDC onshore project cable compared to the DC public exposure limit of 40,000µT. This shows that for the length of the onshore cable route the EMF has been assessed to be less than 1% of the ICNIRP exposure limit.

292. Under both scenarios, a small section of HVAC cabling would be required between the onshore project substation and the national grid substation extension. Table 27.25[8] shows the magnetic fields of the HVAC cables that would be necessary between the onshore project substation and the National Grid substation extension

[17] For information on Norfolk Boreas EMF - https://corporate.vattenfall.co.uk/contentassets/bf0e5e31bbab467eaf02040c7b17513a/vattenfall-emf-information-sheet.pdf

[18] For information on Norfolk Boreas and Hornsea Project Three cable route crossing - https://corporate.vattenfall.co.uk/contentassets/bf0e5e31bbab467eaf02040c7b17513a/vattenfall-orsted-emf-information-sheet.pdf

in comparison with the AC public exposure limit of 360µT. This shows that directly over the buried cables the EMF would be 8% of the exposure limit which quickly drops to less than 1% when over 25m away. It should be noted that:

- the short length of AC cable will be installed as part of the project in land that the public do not have access to; and
- even if standing directly over this cable the strength of the magnetic field would be approximately 60% of that experienced if standing next to a TV or washing machine in the average household (section 27.5.3.8).

293. Exposure limits have been considered between two extremes. The largest magnetic field would be generated if both projects elected to use HVAC export cables; this scenario is not a possible outcome due to Norfolk Boreas Limited's commitment to HVDC, however it provides a useful reference. At the other end of the scale the smallest combined magnetic field would be generated if both projects elect to use HVDC (such that has been committed by both Norfolk Boreas and Norfolk Vanguard):

- Table 27.26[9] shows the (absolute maximum) magnetic field if both Norfolk Boreas and Hornsea Project Three's cables were to operate under HVAC. This represents an exaggerated and unrealistic exposure level due to Norfolk Boreas Limited's commitment to use HVDC. However, this does show that even using this highly conservative approach standing directly over HVAC buried cables the EMF would be 14% of the exposure limit. It should also be noted that a peak magnetic field of 50.7µT at the very worst case is only 0.7µT above the average for a TV, or washing machine in the average household (section 27.5.3.8).
- In the instance that Hornsea Project Three elect to use HVAC these cables along with the HVDC Norfolk Boreas cables would result in overall lower exposure levels than if both projects use HVAC.
- Table 27.27[9] presents (absolute maximum) static magnetic field generation under the scenario that Hornsea Project Three were also to elect to use HVDC. In this case the exposure would be less than 1% of the exposure limit. It should be noted that a static magnetic field would not induce a current in a conducting material (such as the human body) and any health effects related to this are avoided.

Table 27.24 Calculated DC Magnetic Fields from onshore cable route

	Distance perpendicular from centreline of cables (m)			
	Peak	25m	50m	100m
Magnetic field (µT)	33.7	1.27	0.26	0.06
% ICNIRP exposure limit	<1%	<1%	<1%	<1%

Table 27.25 Calculated AC Magnetic Fields from cables between onshore project substation and National Grid extension

	Distance perpendicular from centreline of cables (m)			
	Peak	25m	50m	100m
Magnetic field (µT)	29.7	4.11	0.26	0.03
% ICNIRP exposure limit	8%	1%	<1%	<1%

Table 27.26 Worst-case AC magnetic fields at crossing point

	Distance perpendicular from centreline of cables (m)			
	Peak	25m	50m	100m
Magnetic field (µT)	50.7	1.14	0.49	0.23
% ICNIRP exposure limit	14%	<1%	<1%	<1%

Table 27.27 Worst-case DC magnetic fields at Norfolk Boreas and Hornsea Project Three crossing point

	Distance perpendicular from centreline of cables (m)			
	Peak	25m	50m	100m
Magnetic field (µT)	60.8	1.46	0.59	0.23
% ICNIRP exposure limit	<1%	<1%	<1%	<1%

294. National Grid recommended that no mitigation measures for the cable design and crossing point are necessary as both technology options have been demonstrated to comply with the current public exposure guidelines as detailed in NPS EN-5. If these requirements are met NPS EN-5 states that "no further mitigation should be necessary".

295. Based on the methods described in section 27.3.4 there is not a plausible source-pathway-receptor relationship:

- The source of EMF arising from the onshore cable route, cable crossing point, and onshore project substation are all below regulatory exposure limits;
- There is no demonstrable health effect due to static EMF from HVDC cables and the HVAC elements of the onshore project substation are designed within regulatory standards; and
- Receptors would be people living close to the onshore substation and cable route. But assessment by National Grid shows that, at most, EMF fields would be less than 1% of ICNIRP exposure limit where the public have access and 8% of exposure limits due to the HVAC cables between substations where the public would not have access. EMF would extend to, at most, 100m and all human receptors live beyond this boundary and any that would travel within this boundary would do so for a very short time. A review of scientific literature shows absolutely no link between momentary interaction with EMF fields and health effects.

296. Due to this, the conclusion of the assessment for population health is that there would be **no effect** for the general population or for vulnerable groups due to EMF during operation, under either scenario.

27.6.6 Potential Effects during Decommissioning

297. This section describes the potential impacts of the decommissioning of the onshore infrastructure with regards to effects on Human Health. Further details on decommissioning are provided in Chapter 5 Project Description.

298. No decision has been made regarding the final decommissioning policy for the project, 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.

299. 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 at detailed design phase, but are expected to include:

- Dismantling and removal of outside electrical equipment from outside of the onshore project substation buildings;
- Removal of cabling from site;
- Dismantling and removal of electrical equipment from within the onshore project substation buildings;
- Removal of main onshore project substation building 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.

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

301. The decommissioning methodology would need to be finalised nearer to the end of the lifetime of the project so as 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 licensing and consenting approach.

27.7 Cumulative Effects

302. There are many inter-relationships between determinants of health and health outcomes. This section on inter-relationships considers both intra-project cumulative effects and inter-project cumulative effects. Intra-project effects relate to the combined influence from different aspects of this project on the same population groups. Inter-project effects consider the effect of this project in combination with the expected effects of other projects that may be occurring at a similar time with effects to the same populations.

27.7.1 Intra-project Cumulative Effects

303. Intra-project cumulative effects consider whether there are areas where effects to more than one health determinant by the project may lead to a health outcome.

304. The following section considers the overall effect of different elements of the project on the same population groups. This includes populations geographically defined within the project area, as well as those defined for other sensitivities.

305. Under both scenarios, cumulative intra-project effects are found to be negligible for the general population due to the commitments made as part of the embedded mitigation as a result of consultation and design decisions that have avoided impacts on health determinants.

306. Due to their increased likelihood to spend more time at home and their vulnerability to environmental changes it is assessed that there is an increased likelihood of minor adverse effects on older people, those with existing health conditions and those living in deprived areas.

27.7.1.1 Intra-project Cumulative Effects Scenario 2

307. For Scenario 2 Table 27.28 summarises effects for each geographic population and concludes with a professional judgement of the intra-project cumulative effect. Table 27.29 similarly summarises the effects relevant to each vulnerable group and concludes with a professional judgement of the intra-project cumulative effect score.

27.7.1.2 Intra-project Cumulative Effects Scenario 1

308. For Scenario 1 Table 27.30 summarises effects for each geographic population and concludes with a professional judgement of the intra-project cumulative effect. Table 27.31 similarly summarises the effects relevant to each vulnerable group and concludes with a professional judgement of the intra-project cumulative effect.

Table 27.28 Intra-project cumulative effects for site specific population groups under Scenario 2

	Site-specific		
	Population near landfall	**Population along the onshore cable route**	**Population near the onshore project substation and National Grid substation extension**
Description of cumulative effect	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; • Indirect Employment; and • Journey times or reduced access.	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities • Indirect Employment; • EMF; and • Journey times or reduced access.	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; • Indirect Employment; • EMF; and • Journey times or reduced access.
	The general population intra-project cumulative effect is considered to be **negligible** due to the very short temporal scope of negligible effects and the avoidance of significant impacts through design decisions.	The general population intra-project cumulative effect is considered to be **negligible**. This is due to the sequential construction process which results in negligible effects of very short temporal scope at individual locations.	The general population intra-project cumulative effect is considered to be n**egligible**. Consultation and site selection has led to design decisions that reduce the likelihood of health outcomes due to accumulated effects.
	For relevant vulnerable groups, combined proximity and increased sensitivity may result in a **minor adverse** intra-project cumulative effect. This is because, although the effects are negligible and transient, due to the likelihood of vulnerable groups being at home during the day they may feel the effects accumulate more rapidly.	For relevant vulnerable groups, combined proximity and increased sensitivity may result in a **minor adverse** intra-project cumulative effect. This is because, although the effects are negligible and transient, due to the likelihood of vulnerable groups being at home during the day they may feel the effects accumulate more rapidly.	For relevant vulnerable groups, combined proximity and increased sensitivity may result in a **minor adverse** intra-project cumulative effect. The cumulative effect on physical health is negligible but it is considered that anxiety due to perceived risk may result in short term minor adverse health effects.

Table 27.29 Intra-project cumulative effect for potentially vulnerable groups within site specific populations under Scenario 2

	Potentially vulnerable groups			
	Children and young people	**Older people**	**People with existing poor health (physical and mental health)**	**People living in deprivation, including those on low incomes**
Description of cumulative effect	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; and • Journey times or reduced access.	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; • EMF; and • Journey times or reduced access.	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; • EMF; and • Journey times or reduced access.	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; • Employment; and • Journey times or reduced access.
	The intra-project cumulative effect for this group, taking account of differing effects across geographic levels, is considered to be **negligible**. This is because the main effect on children would be a change in conditions that reduce their ability to concentrate while at school but design decisions have avoided these effects.	The intra-project cumulative effect for this group, taking account of differing effects across geographic levels, is considered to be **minor adverse** due to the increased percentage of older people in the community and the likelihood that they would spend more time at home where they may feel the effects accumulate more rapidly.	The intra-project cumulative effect for this group, taking account of differing effects across geographic levels, is considered to be **minor adverse** because they are more likely to be at home where they may feel the effects accumulate more rapidly and may feel anxiety more acutely due to their existing conditions.	The intra-project cumulative effect for this group, taking account of differing effects across geographic levels, is considered to be **negligible**. On the one hand deprivation may increase their vulnerability of effects but on the other hand the increased opportunity for training and employment may have a beneficial effect.

Table 27.30 Intra-project cumulative effects for site specific population groups under Scenario 1

	Site-specific		
	Population near landfall	**Population along the onshore cable route**	**Population near the onshore project substation and National Grid substation extension**
Description of cumulative effect	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; • Indirect Employment; and • Journey times or reduced access.	Cumulative effects relate to the combined population health influences during cable pulling only from: • Noise; • Air quality; • Physical activities • Indirect Employment; • EMF; and • Journey times or reduced access.	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; • Indirect Employment; • EMF; and • Journey times or reduced access.
	The general population intra-project cumulative effect is considered to be **negligible** due to the very short temporal scope of negligible effects and the avoidance of significant impacts through design decisions.	The general population intra-project cumulative effect is considered to be **negligible**. This is due to the very localised effect of cable pulling which results negligible effects of very short temporal scope at individual locations.	The general population intra-project cumulative effect is considered to be **negligible**. Consultation and site selection has led to design decisions that reduce the likelihood of health outcomes due to accumulated effects.
	For relevant vulnerable groups, combined proximity and increased sensitivity may result in a **minor adverse** intra-project cumulative effect. This is because, although the effects are negligible and transient, due to the likelihood of vulnerable groups being at home during the day they may feel the effects accumulate more rapidly.	For relevant vulnerable groups, combined proximity and increased sensitivity may also result in a **negligible** intra-project cumulative effect. This is because, although the effects are negligible and transient, due to the likelihood of vulnerable groups being at home during the day they may feel the effects accumulate more rapidly.	For relevant vulnerable groups, combined proximity and increased sensitivity may result in a **minor adverse** intra-project cumulative effect. The cumulative effect on physical health is negligible but it is considered that anxiety due to perceived risk may result in short term minor adverse health effects.

Table 27.31 Intra-project cumulative effect for potentially vulnerable groups within site specific populations under Scenario 1

	Potentially vulnerable groups			
	Children and young people	**Older people**	**People with existing poor health (physical and mental health)**	**People living in deprivation, including those on low incomes**
Description of cumulative effect	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; and • Journey times or reduced access.	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; • EMF; and • Journey times or reduced access.	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; • EMF; and • Journey times or reduced access.	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; • Employment; and • Journey times or reduced access.
	The intra-project cumulative effect for this group, taking account of differing effects across geographic levels, is considered to be **negligible**. This is because the main effect on children would be a change in conditions that reduce their ability to concentrate while at school but design decisions have avoided these effects.	The intra-project cumulative effect for this group, taking account of differing effects across geographic levels, is considered to be **minor adverse** due to the increased percentage of older people in the community and the likelihood that they would spend more time at home where they may feel the effects accumulate more rapidly.	The intra-project cumulative effect for this group, taking account of differing effects across geographic levels, is considered to be **minor adverse** because they are more likely to be at home where they may feel the effects accumulate more rapidly and may feel anxiety more acutely due to their existing conditions.	The intra-project cumulative effect for this group, taking account of differing effects across geographic levels, is considered to be **negligible**. On the one hand deprivation may increase their vulnerability of effects but on the other hand the increased opportunity for training and employment may have a beneficial effect.

27.7.2 Inter-project Cumulative Effects

309. Inter-project cumulative effects are those effects that would increase due to the presence of more than one project in an area. However, due to the geographic and temporal spread of the relevant projects, this assessment concludes that populations are unlikely to feel a significant increase in health effects as a result of multiple projects being constructed. This is reinforced by the decision to install the ducts for Norfolk Boreas during the Norfolk Vanguard duct installation phase (Scenario 1) and therefore avoiding the accumulation of effects on local populations as well as the decision to pursue the HVDC electrical connection only.

310. The following section considers the overall effect of Norfolk Boreas in combination with other projects on health. This includes consideration of geographically defined populations, as well as those defined for other sensitivities. Whilst Dudgeon has been constructed and is in operation, it is considered in this assessment because as it is still a recent project, communities may still feel its effects cumulatively with projects in development.

311. Under Scenario 2 Norfolk Vanguard would not exist and therefore is not assessed cumulatively. Under Scenario 1 the duct installation for the onshore cable route for Norfolk Boreas will be conducted as part of Norfolk Vanguard construction. Therefore, the elements of Norfolk Vanguard that are considered in the CIA are the Norfolk Vanguard cable pulling and onshore project substation (including the National Grid substation extension).

312. Projects identified for potential cumulative impacts have been agreed as part of the Norfolk Boreas PEIR consultation (Norfolk Boreas Limited, 2018). These projects, as well as any relevant development applications submitted since this consultation have been considered and their anticipated potential for cumulative impact are detailed in Table 27.32.

Table 27.32 Summary of projects considered for inter-project cumulative health effects (Scenario 1 and 2)

Project	Status	Development period	[1]Distance from Norfolk Boreas site (km)	Project definition	Project data status	Included in CIA	Rationale
National Infrastructure Planning							
Norfolk Vanguard Offshore Wind Farm	Application submitted	Expected construction 2020 to 2025	0 – projects are co-located	Full ES available: https://infrastructure.planninginspectorate.gov.uk/projects/eastern/norfolk-vanguard/?ipcsection=docs	High	Only included under Scenario 1.	If Norfolk Vanguard and Norfolk Boreas both receive consent then the duration of effect will be longer. Although the magnitude at latter stages will be lower because most of the works for Norfolk Boreas will have been undertaken by Norfolk Vanguard.
Hornsea Project Three Offshore Wind Farm	Application submitted	Expected construction start date 2021. Duration 6 to 10 years dependent on phasing.	0 – cable intersects project 32km between substation locations	Full ES available: https://infrastructure.planninginspectorate.gov.uk/projects/eastern/hornsea-project-three-offshore-wind-farm/?ipcsection=docs	High	Yes	Overlapping proposed project boundaries at Reepham may result in impacts of a direct and / or indirect nature during construction and operation. There is also the potential for cumulative traffic impacts during construction.
Dudgeon Offshore Wind Farm	Commissioned	Constructed	0	http://dudgeonoffshorewind.co.uk/	High	Yes	The Dudgeon onshore cable route is to the north of Norfolk Boreas, connecting to the grid at Necton, on the same site as the connection for Norfolk Boreas. Community comments received during consultation express frustration due to impacts from this project. Therefore, the cumulative impact will probably be felt more through a negative perception relating to communities.

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

Project	Status	Development period	[1]Distance from Norfolk Boreas site (km)	Project definition	Project data status	Included in CIA	Rationale
A47 corridor improvement programme – North Tuddenham to Easton	Pre-application	Expected construction 2021 to 2022	26.7	https://infrastructure.planninginspectorate.gov.uk/projects/eastern/a47-north-tuddenham-to-easton/	Medium	No	It is unlikely that the determinants of health considered in this chapter will be cumulatively affected by a project that is 26.7km from site.
A47 corridor improvement programme – A47 Blofield to North Burlingham	Pre-application	Expected construction 2021 to 2022	23	https://infrastructure.planninginspectorate.gov.uk/projects/eastern/a47-blofield-to-north-burlingham/	Medium	No	It is unlikely that the determinants of health considered in this chapter will be cumulatively affected by a project that is 23km from site.
A47 corridor improvement programme – A47 / A11 Thickthorn	Pre-application	Expected construction 2020 to 2021	18	https://infrastructure.planninginspectorate.gov.uk/projects/eastern/a47a11-thickthorn-junction/	Medium	No	It is unlikely that the determinants of health considered in this chapter will be cumulatively affected by a project that is 18km from site.
Norwich Western Link	Pre-application	Expected construction start 2022	2.8	https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/norwich/norwich-western-link/timeline	Medium	No	With regards to the potential for cumulative impacts associated with the potential overlap of construction traffic, noting the lack of information available at this stage, it is not possible to provide a meaningful assessment of cumulative impacts. It is therefore proposed that, if approved, through the development of the

Project	Status	Development period	[1]Distance from Norfolk Boreas site (km)	Project definition	Project data status	Included in CIA	Rationale
							construction traffic management plan (CTMP), Norfolk Boreas Limited and its Contractors would engage stakeholders to try and establish opportunities to co-ordinate activities and avoid peak traffic impacts.
Third River Crossing (Great Yarmouth)	Pre-application	Expected construction to start in 2020	28	https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/great-yarmouth/third-river-crossing	Medium	No	Analysis does show that the port of Great Yarmouth is a strategic port for the offshore wind industry in the East of England and industrial areas have been designated for development. Therefore, there may be some cumulative effect due to this. However, development of the port and associated industrial areas would be consented separately and therefore is outside the scope of this assessment.
King's Lynn B Power Station amendments	Pre-application	Expected construction 2018 to 2021	28	https://www.kingslynnbccgt.co.uk/	Medium	No	Works due to be completed before the project programme is due to begin.
North Norfolk District Council							
PF/17/1951 Erection of 43 dwellings and new access with associated	Awaiting decision	Anticipated Q2 2018	0.7	Application available: https://idoxpa.north-norfolk.gov.uk/online-applications/applicationDetails.do?activeTab=su	High	No	Works due to be completed before the project programme is due to begin.

Project	Status	Development period	[1]Distance from Norfolk Boreas site (km)	Project definition	Project data status	Included in CIA	Rationale
landscaping, highways and external works, and amendments to substation)				mmary&keyVal=_NNORF_DCAPR_92323			
Bacton and Walcott Coastal Management Scheme	Submitted	Construction start date 2019	1.0	Public information leaflets available: https://www.north-norfolk.gov.uk/media/3371/bacton-to-walcott-public-information-booklet-july-2017.pdf	Medium	Yes	Coastal management schemes have a potential to increase suspended sediment level during construction which has a small chance of leading to health effects. On the other hand, coastal management and protection has a long term beneficial effect that would outweigh the short term construction effect by protecting communities from increased risk due to climate change.
Coastal defence/protection works, Happisburgh PF/18/0751	Approved	Coastal protection over 10 year duration from August 2018.	0.12	https://idoxpa.north-norfolk.gov.uk/online-applications/applicationDetails.do?activeTab=summary&keyVal=_NNORF_DCAPR_93543	Medium	Yes	
Breckland Council							
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	There are three ways that housing developments could cumulatively effect communities: • Through disturbance due to noise, vibration, or dust; • Through cumulative distortion to the labour market; and

Project	Status	Development period	[1]Distance from Norfolk Boreas site (km)	Project definition	Project data status	Included in CIA	Rationale
98 dwellings at Swans Nest with access from Brandon Road (3PL/2017/1351/F) (Phase 3 of 3PL/2012/0576/O)	Awaiting decision	Not known. Application submitted Jan 2016.	6.4	http://planning.breckland.gov.uk/OcellaWeb/planningDetails?reference=3PL/2017/1351/F&from=planningSearch	Medium	No	• Through traffic delays. These projects are far enough from the onshore project substation area for cumulative noise, vibration, and dust impacts not to arise on community infrastructure receptors. Construction workers that could transfer between the housing developments and the project would probably be providing general services. The increase in demand of these services due to the project is insignificant in comparison to the size of the labour market therefore this will not be considered further. Potential for increased traffic density is considered in Chapter 24 Transport and Traffic. It is not possible to determine if these will culminate in community impacts but this is considered highly unlikely due to the low level of human health outcomes assessed in Chapter 27 Human Health for Norfolk Boreas alone.
175 dwellings with access at land to west of Watton Road, Swaffham (3PL/2016/0068/O) (Swans Nest Phase B)	Awaiting decision	Not known. Application submitted Jan 2016.	6.4	http://planning.breckland.gov.uk/OcellaWeb/planningDetails?reference=3PL/2016/0068/O	Medium	No	

313. In summary, the following projects will be assessed for potential direct cumulative effects:

Scenario 1

- Norfolk Vanguard Offshore Wind Farm
- Hornsea Project Three Offshore Wind Farm
- Dudgeon Offshore Wind Farm
- Bacton and Walcott Coastal Management Scheme
- Coastal defence/protection works, Happisburgh PF/18/0751

Scenario 2

- Hornsea Project Three Offshore Wind Farm
- Dudgeon Offshore Wind Farm
- Bacton and Walcott Coastal Management Scheme
- Coastal defence/protection works, Happisburgh PF/18/0751

314. Table 27.33 (Scenario 2) and Table 27.35 (Scenario 1) summarises effects for each geographic population and concludes with a professional judgement of the inter-project cumulative effect. Table 27.34 (Scenario 2) and Table 27.36 (Scenario 1) similarly summarises the effects relevant to each vulnerable group and concludes with a professional judgement of the intra-project cumulative effect.

Table 27.33 Inter-project cumulative effects for geographic population groups under Scenario 2

Description of Cumulative effects					
Site-specific Population near landfall	**Population along the onshore cable route**	**Population near the onshore project substation**	**Local Population of North Norfolk, Broadland and Breckland Districts**	**Regional Population of Norfolk County**	**National and international Population of the England and beyond the borders of England**
Cumulative effects relate to the combined population health influences from: • Bacton and Walcott Coastal Management Scheme ; and • Coastal defence/protection work, Happisburgh PF/18/0751	Cumulative effects relate to the combined population health influences from: • Dudgeon; and • Hornsea Project Three.	Cumulative effects relate to the combined population health influences from: • Dudgeon.	Cumulative effects relate to the combined population health influences from: • Dudgeon; • Hornsea Project Three; • Bacton Coastal Management and • Coastal defence/protection work, Happisburgh PF/18/0751		Cumulative effects relate to the combined population health influences from: • Dudgeon; and • Hornsea Project Three.
The general population inter-project cumulative effect is considered to be **negligible** because the various works at Bacton are far enough away to not lead to health effects at landfall.	The general population inter-project cumulative effect is considered to be **negligible** because the cable route for Dudgeon has been constructed. There is also only one location where Norfolk Boreas's cable will cross Hornsea Project Three and through implementation of best available practices potential cumulative impacts can be managed.	The general population inter-project cumulative effect is considered to be **negligible** because Dudgeon has already been constructed. Therefore, the combined effects are unlikely to lead to further health effects.	The general population inter-project cumulative effect is considered to be **negligible**. Due to the projects being distributed across the area the cumulative effects due to noise or air quality are likely to negligible. The effect on increased employment may be minor beneficial but the increase in traffic may be minor adverse.		The general population inter-project cumulative effect is considered to be **moderate beneficial** due to the reduction in carbon dioxide emissions as a result of constructing utility scale renewable energy generation. This leads to a myriad of environmental and health benefits to support a more sustainable society.
For relevant vulnerable groups, combined proximity and increased sensitivity may also result in a **minor**	For relevant vulnerable groups, combined proximity and increased sensitivity may result in a **minor adverse**	For relevant vulnerable groups, combined proximity and increased sensitivity may result in a **minor adverse**	For relevant vulnerable groups, combined proximity and increased sensitivity may result in a **minor adverse** inter-project		For relevant vulnerable groups, combined proximity and increased sensitivity may result in a **moderate beneficial** inter-project cumulative

Description of Cumulative effects					
Site-specific Population near landfall	Population along the onshore cable route	Population near the onshore project substation	Local Population of North Norfolk, Broadland and Breckland Districts	Regional Population of Norfolk County	National and international Population of the England and beyond the borders of England
adverse inter-project cumulative effect.	inter-project cumulative effect. This is due to strong opinions of the perceived effect of the construction of Dudgeon's cable route which may create increased anxiety about further projects.	inter-project cumulative effect. This is due to strong opinions of the perceived effect of the construction of Dudgeon's onshore project substation which may create increased anxiety about further projects.	cumulative effect. The magnitude of effects would be the same as the general population but the increased sensitivity may lead to a slightly greater likelihood of negative health outcomes.		effect. Similarly, the mitigation of climate change may be beneficial but also the development of offshore wind increases the employment potential in deprived areas and offsets the down turn in employment in the offshore oil industry.

Table 27.34 Inter-project cumulative effect for potentially vulnerable groups within geographic populations under Scenario 2

	Potentially vulnerable groups Children and young people	Older people	People with existing poor health (physical and mental health)	People living in deprivation, including those on low incomes
Description of cumulative effect	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; and • Journey times or reduced access.	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; • EMF; and • Journey times or reduced access.	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; • EMF; and • Journey times or reduced access.	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; • Employment; and • Journey times or reduced access.
	The main effect on children would be a change in conditions that reduce their ability to concentrate while at school but design decisions have avoided these effects. Therefore the cumulative effect is considered **negligible**.	Due to the increased percentage of older people in the community and the likelihood that they would spend more time at home where they may feel the effects accumulate more rapidly. The inter-project cumulative effect is considered to be **minor adverse.**	The inter-project cumulative effect is considered to be **minor adverse** because they are more likely to be at home where they may feel the effects accumulate more rapidly and may feel anxiety more acutely due to their existing conditions.	The inter-project cumulative effect is considered to be **negligible**. On the one hand deprivation may increase their vulnerability of effects but on the other hand the increased opportunity for training and employment may have a minor beneficial effect.

Table 27.35 Inter-project cumulative effects for geographic population groups under Scenario 1

Description of Cumulative effects					
Site-specific Population near landfall	**Population along the onshore cable route**	**Population near the onshore project substation**	**Local Population of North Norfolk, Broadland and Breckland Districts**	**Regional Population of Norfolk County**	**National and international Population of the England and beyond the borders of England**
Cumulative effects relate to the combined population health influences from: • Norfolk Vanguard; • Bacton and Walcott Coastal Management Scheme ; and • Coastal defence/protection work, Happisburgh PF/18/0751	Cumulative effects relate to the combined population health influences from: • Norfolk Vanguard; • Dudgeon; and • Hornsea Project Three.	Cumulative effects relate to the combined population health influences from: • Norfolk Vanguard; and • Dudgeon.	Cumulative effects relate to the combined population health influences from: • Norfolk Vanguard; • Dudgeon; • Hornsea Project Three; and • Bacton Coastal Management and • Coastal defence/protection work, Happisburgh PF/18/0751		Cumulative effects relate to the combined population health influences from: • Norfolk Vanguard; • Dudgeon; and • Hornsea Project Three.
The general population inter-project cumulative effect is considered to be **negligible** due to the co-location of the landfall for Norfolk Boreas and Norfolk Vanguard which are far enough away from the various works at Bacton to not lead to health effects at landfall.	The general population inter-project cumulative effect is considered to be **negligible** because the cable route for Dudgeon has been constructed and Norfolk Vanguard would have installed the ducts for the onshore cable route for Norfolk Boreas. There is also only one location where Norfolk Vanguard's cable will cross Hornsea Project Three and through implementation of best available practices potential cumulative impacts can be managed.	The general population inter-project cumulative effect is considered to be **negligible** because Dudgeon has already been constructed and Norfolk Boreas would include a similar level of embedded mitigation to Norfolk Vanguard. Therefore, the combined effects are unlikely to lead to further health effects.	The general population inter-project cumulative effect is considered to be **negligible**. Due to the projects being distributed across the area the cumulative effects due to noise or air quality are likely to negligible. The effect on increased employment may be minor beneficial but the increase in traffic may be minor adverse.		The general population inter-project cumulative effect is considered to be **moderate beneficial** due to the reduction in carbon dioxide emissions as a result of constructing utility scale renewable energy generation. This leads to a myriad of environmental and health benefits to support a more sustainable society.

Description of Cumulative effects					
Site-specific Population near landfall	**Population along the onshore cable route**	**Population near the onshore project substation**	**Local Population of North Norfolk, Broadland and Breckland Districts**	**Regional Population of Norfolk County**	**National and international Population of the England and beyond the borders of England**
For relevant vulnerable groups, combined proximity and increased sensitivity may also result in a **minor adverse** inter-project cumulative effect.	For relevant vulnerable groups, combined proximity and increased sensitivity may result in a **minor adverse** inter-project cumulative effect. This is due to strong opinions of the perceived effect of the construction of Dudgeon's cable route which may create increased anxiety about further projects.	For relevant vulnerable groups, combined proximity and increased sensitivity may result in a **minor adverse** inter-project cumulative effect. This is due to strong opinions of the perceived effect of the construction of Dudgeon's onshore project substation which may create increased anxiety about further projects.	For relevant vulnerable groups, combined proximity and increased sensitivity may result in a **minor adverse** inter-project cumulative effect. The magnitude of effects would be the same as the general population but the increased sensitivity may lead to a slightly greater likelihood of negative health outcomes.		For relevant vulnerable groups, combined proximity and increased sensitivity may result in a **moderate beneficial** inter-project cumulative effect. Similarly, the mitigation of climate change may be beneficial but also the development of offshore wind increases the employment potential in deprived areas and offsets the down turn in employment in the offshore oil industry.

Table 27.36 Inter-project cumulative effect for potentially vulnerable groups within geographic populations under Scenario 1

	Potentially vulnerable groups Children and young people	Older people	People with existing poor health (physical and mental health)	People living in deprivation, including those on low incomes
Description of cumulative effect	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; and • Journey times or reduced access.	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; • EMF; and • Journey times or reduced access.	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; • EMF; and • Journey times or reduced access.	Cumulative effects relate to the combined population health influences from: • Noise; • Air quality; • Physical activities; • Employment; and • Journey times or reduced access.
	The main effect on children would be a change in conditions that reduce their ability to concentrate while at school but design decisions have avoided these effects. Therefore the cumulative effect is considered **negligible**.	Due to the increased percentage of older people in the community and the likelihood that they would spend more time at home where they may feel the effects accumulate more rapidly. The inter-project cumulative effect, is considered to be **minor adverse.**	The inter-project cumulative effect is considered to be **minor adverse** because they are more likely to be at home where they may feel the effects accumulate more rapidly and may feel anxiety more acutely due to their existing conditions.	The inter-project cumulative effect is considered to be **negligible**. On the one hand deprivation may increase their vulnerability of effects but on the other hand the increased opportunity for training and employment may have a minor beneficial effect.

27.8 Summary

315. After consideration of potential health effects during the construction and operation phases of the project, there are not predicted to be any significant effects on physical or mental health as a result of the project under either Scenario 1 or Scenario 2.

27.8.1 Scenario 1 Summary

316. See Table 27.37 for a summary of the potential health effects and

317. Table 27.38 for potential intra-related and inter-related effects under Scenario 1.

Table 27.37 Potential effects identified for Scenario 1

Potential effects	Temporal scope	Probability of effect	Sensitivity of		Magnitude of effect	Significance of effect on	
			General population	Vulnerable population		General population	Vulnerable population
Construction							
Noise	Mainly short term	Plausible	Low	High	Low	**Negligible**	**Minor adverse**
Air quality	Mainly short term	Plausible	Low	High	Low	**Negligible**	**Minor adverse**
Ground/ water contamination	Short term	Plausible	Medium	High	Low	**Negligible**	**Negligible**
Physical activity	Very short term	Likely	Medium	High	None	**Negligible**	**Negligible**
Journey times or reduced access	Short term	Likely	Low	High	Low	**Negligible**	**Minor adverse**
Construction and Operation							
Employment	Medium to long term	Likely	Medium	High	Low	**Negligible**	**Minor beneficial**
Operation							
Noise	Long term	Low probability	Low	High	None	**No effect**	**No effect**
EMF and public understanding of risk	Medium term	Low probability	Medium	High	None	**No effect**	**No effect**

Potential effects	Temporal scope	Probability of effect	Sensitivity of		Magnitude of effect	Significance of effect on	
			General population	Vulnerable population		General population	Vulnerable population
Decommissioning							
The possible health effects arising from the decommissioning of the project are considered to be no worse than those considered for construction.							

Table 27.38 Summary of intra-related and inter-related health effects for Scenario 1

Population group	Intra-project effects		Inter-project effects	
	General population	Vulnerable population	General population	Vulnerable population
Site-specific Population near landfall	**Negligible**	**Minor adverse**	**Negligible**	**Minor adverse**
Population along the onshore cable route	**Negligible**	**Minor adverse**	**Negligible**	**Minor adverse**
Population near the onshore project substation	**Negligible**	**Minor adverse**	**Negligible**	**Minor adverse**
Local population of North Norfolk, Broadland and Breckland Districts[19]	n/a	n/a	**Negligible**	**Minor adverse**
Regional population of Norfolk County[12]	n/a	n/a		
National and international population of England and beyond the borders of England[12]	n/a	n/a	**Moderate beneficial**	**Moderate beneficial**
Children and young people	**Negligible**		**Negligible**	
Older people	**Minor adverse**		**Minor adverse**	
People with existing poor health (physical and mental health)	**Minor adverse**		**Minor adverse**	
People living in deprivation, including those on low incomes	**Negligible**		**Negligible**	

[19] Intra-project effects are not considered at spatial scale of District or above because these are localised and would only be felt by individual communities.

27.8.2 Scenario 2 Summary

318. See Table 27.39 for a summary of the potential health effects and Table 27.40 for a summary of intra-related and inter-related effects under Scenario 2.

Table 27.39 Potential effects identified for Scenario 2

Potential effects	Temporal scope	Probability of effect	Sensitivity of		Magnitude of effect	Significance of effect on	
			General population	Vulnerable population		General population	Vulnerable population
Construction							
Noise	Mainly short term	Plausible	Low	High	Low	**Negligible**	**Minor adverse**
Air quality	Mainly short term	Plausible	Low	High	Low	**Negligible**	**Minor adverse**
Ground/water contamination	Short term	Plausible	Medium	High	Low	**Negligible**	**Negligible**
Physical activity	Very short term	Likely	Medium	High	Low	**Negligible**	**Negligible**
Journey times or reduced access	Short term	Likely	Low	High	Low	**Negligible**	**Minor adverse**
Construction and Operation							
Employment	Medium to long term	Likely	Medium	High	Low	**Negligible**	**Minor beneficial**
Operation							
Noise	Long term	Low probability	Low	High	None	**No effect**	**No effect**
EMF and public understanding of risk	Medium term	Low probability	Medium	High	None	**No effect**	**No effect**
Decommissioning							
The possible health effects arising from the decommissioning of the project are considered to be no worse than those considered for construction.							

Table 27.40 Summary of intra-related and inter-related health effects for Scenario 2

Population group	Intra-project effects		Inter-project effects	
	General population	Vulnerable population	General population	Vulnerable population
Site-specific population near landfall	**Negligible**	**Minor adverse**	**Negligible**	**Minor adverse**
Population along the onshore cable route	**Negligible**	**Minor adverse**	**Negligible**	**Minor adverse**
Population near the onshore project substation	**Negligible**	**Minor adverse**	**Negligible**	**Minor adverse**
Local population of North Norfolk, Broadland and Breckland Districts[20]	n/a	n/a	**Negligible**	**Minor adverse**
Regional population of Norfolk County[12]	n/a	n/a		
National and international population of England and beyond the borders of England[12]	n/a	n/a	**Moderate beneficial**	**Moderate beneficial**
Children and young people	**Negligible**		**Negligible**	
Older people	**Minor adverse**		**Minor adverse**	
People with existing poor health (physical and mental health)	**Minor adverse**		**Minor adverse**	
People living in deprivation, including those on low incomes	**Negligible**		**Negligible**	

[20] Intra-project effects are not considered at spatial scale of District or above because these are localised and would only be felt by individual communities.

27.9 References

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