

East Anglia TWO Offshore Windfarm

Appendix 27.1

Scientific Literature

Preliminary Environmental Information

Volume 3

Document Reference: EA2-DEVWF-ENV-REP-IBR-
000822_001

Revision Summary					
Rev	Date	Document Status	Prepared by	Checked by	Approved by
01	11/01/2019	For Issue	Paolo Pizzolla	Julia Bolton	Helen Walker

Description of Revisions			
Rev	Page	Section	Description
01	n/a	n/a	Final Draft

Table of Contents

27.1	Scientific Literature	1
27.1	Introduction	1
27.2	Literature per Determinant	1
27.3	References	7

Glossary of Acronyms

HVDC	High Voltage Direct Current
EMF	Electromagnetic Field
PHE	Public Health England
PM	Particulate Matter
GIS	Gas Insulated Switchgear
WHO	World Health Organisation

Glossary of Terminology

Applicant	East Anglia TWO Limited.
Construction consolidation sites	Compounds which will contain laydown, storage and work areas for onshore construction works. The HDD construction compound will also be referred to as a construction consolidation site.
Development Area	Area containing all onshore and offshore infrastructure, transmission works, construction consolidation sites, and mitigation areas.
East Anglia TWO project	The proposed project consisting of up to 75 wind turbines, up to four offshore electrical platforms, up to one construction operation and maintenance platform, inter-array cables, platform link cables, up to one operational meteorological mast, up to two offshore export cables, fibre optic cables, landfall infrastructure, onshore cables and ducts, onshore substation, and National Grid infrastructure.
European site	Sites designated for nature conservation under the Habitats Directive and Birds Directive, as defined in regulation 8 of the Conservation of Habitats and Species Regulations 2017 and regulation 18 of the Conservation of Offshore Marine Habitats and Species Regulations 2017. These include candidate Special Areas of Conservation, Sites of Community Importance, Special Areas of Conservation and Special Protection Areas.
Evidence Plan Process	A voluntary consultation process with specialist stakeholders to agree the approach to the EIA and the information required to support HRA.
Horizontal directional drilling (HDD)	A method of cable installation where the cable is drilled beneath a feature without the need for trenching.
Jointing Bay	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	The area where the offshore export cables would make contact with land, and connect to the onshore cables.
Link boxes	Underground chambers or above ground cabinets next to the cable trench housing electrical earthing links.
Mitigation areas	Areas captured within the Development Area specifically for mitigating expected or anticipated impacts.
National Grid infrastructure	A National Grid substation, connection to the existing electricity pylons and National Grid overhead line realignment works which will be consented as part of the proposed East Anglia TWO project Development Consent Order but will be National Grid owned assets.
National Grid overhead line realignment works	Works required to upgrade the existing electricity pylons and overhead lines to transport electricity from the National Grid substation to the national electricity grid
National Grid overhead line realignment works area	The proposed area for National Grid overhead line realignment works.

National Grid substation	The substation (including all of the electrical equipment within it) necessary to connect the proposed East Anglia TWO project to the national electricity grid which will be owned by National Grid but is being consented as part of the proposed East Anglia TWO project Development Consent Order.
National Grid substation location	The proposed location of the National Grid substation required to connect the proposed East Anglia TWO project to the national electricity grid.
Natura 2000 site	A site forming part of the network of sites made up of Special Areas of Conservation and Special Protection Areas designated respectively under the Habitats Directive and Birds Directive.
Onshore cable corridor	The corridor within which the onshore cable route will be located.
Onshore cable route	This is the construction swathe within the onshore cable corridor which would contain onshore cables as well as temporary ground required for construction which includes cable trenches, haul road and spoil storage areas.
Onshore cables	The cables which would bring electricity from landfall to the onshore substation. The onshore cable is comprised of up to six power cables and two fibre optic cables.
Proposed onshore development area	The area in which the landfall, onshore cable corridor, onshore substation, mitigation areas, temporary construction facilities (such as access roads and construction consolidation sites), and the National Grid Infrastructure will be located.
Onshore infrastructure	The combined name for all infrastructure associated with the proposed East Anglia TWO project from landfall to grid connection.
Onshore substation	The East Anglia TWO substation and all of the electrical equipment within in.
Onshore substation location	The proposed location of the onshore substation for the proposed East Anglia TWO project.
Onshore study area	All onshore areas being considered for the placement of onshore infrastructure or temporary construction consolidation sites. This includes areas being considered for National Grid infrastructure, East Anglia TWO onshore substation, onshore cable corridor and landfall.
Transition Bay	Underground structures at the landfall that house the joints between the offshore export cables and the onshore cables.

27.1 Scientific Literature

27.1 Introduction

1. This document is **Appendix 27.1** to **Chapter 27 Human Health**. The review is not exhaustive and aims to provide a summary only of the key issues relevant to the scope of **Chapter 27 Human Health** in relation to:
 - Noise;
 - Air Quality;
 - Ground and / or Water Contamination;
 - Physical Activity;
 - Journey Times and / or Reduced Access;
 - Employment; and
 - Electromagnetic Fields.
2. An evidence base of publicly available information has been used to support the scoping and assessment conclusions of **Chapter 27 Human Health** for the proposed East Anglia TWO project. Evidence statements have been extracted from a review of abstracts and full articles published in English on PubMed from the past five years.

27.2 Literature per Determinant

27.2.1 Noise

3. Noise is pervasive in everyday life and can cause both auditory and non-auditory health effects. Although people tend to habituate to noise exposure, degree of habituation differs for individuals and is rarely complete. If exposure to noise is chronic and exceeds certain levels, then negative health outcomes can be seen (Basner et al. 2014).
4. Environmental noise (e.g. noise from road, rail, and air traffic as well as industrial construction) has been linked to a range of non-auditory health effects including annoyance, sleep disturbance, cardiovascular disease, and impairment of cognitive performance in children (Basner et al. 2014).
5. Annoyance is the most prevalent community response in a population exposed to environmental noise. Noise annoyance can result from noise interfering with daily activities, feelings, thoughts, sleep, or rest, and might be accompanied by negative responses, such as anger, displeasure, exhaustion, and by stress-related symptoms. In severe forms, it could be thought to affect wellbeing and health, and

because of the high number of people affected, annoyance substantially contributes to the burden of disease from environmental noise. Although the overall community response depends on societal values, several personal (e.g. age and noise sensitivity) and situational characteristics (e.g. dwelling insulation) might affect the individual degree of annoyance (Basner et al. 2014).

6. Sleep disturbance is thought to be the most deleterious non-auditory effect of environmental noise exposure, because undisturbed sleep of a sufficient length is needed for daytime alertness and performance, quality of life, and health. Human beings perceive, evaluate, and react to environmental sounds, even while asleep. Elderly people, children, shift-workers, and people with a pre-existing (sleep) disorder are thought of as at-risk groups for noise-induced sleep disturbance (Basner et al. 2014).
7. Regarding noise and health, groups at risk most often mentioned in the literature are children, the elderly, the chronically ill and people with a hearing impairment. Other categories encountered are those of sensitive persons, shift-workers, people with mental illness (e.g., schizophrenia or autism), people suffering from tinnitus, and foetuses and neonates (van Kamp and Davies 2013).
8. The available evidence shows that children are less vulnerable to annoyance than adults, but more vulnerable for cognitive effects of noise. They are not per se more vulnerable as a group, but more at risk because of less-developed coping strategies, and they are in a sensitive developmental period. This is indicative of a life phase effect rather than an age effect. Children seem to be less vulnerable for awakenings due to noise but more vulnerable for physiological effects during sleep and related motility (van Kamp and Davies 2013).
9. Evidence does not indicate that the elderly are more vulnerable to noise in terms of annoyance and sleep disturbance. Age-specific comparisons rather show an inverted U-shaped relationship and indicate that both young and older people are less at risk as far as annoyance and disturbance are concerned. But, possibly, the elderly are more vulnerable regarding cardiovascular effects, and this may be a combined effect of air pollution and noise (van Kamp and Davies 2013).

27.2.2 Air Quality

10. Air pollution is a heterogeneous and a complex mixture of dust, particulate matter (PM), fumes, gases, carbon monoxide, nitrogen dioxide, sulphur dioxide and ozone. Environmental air pollution is associated with increased risk of cardiovascular diseases (Meo and Suraya 2015) and with moderate or severe asthma exacerbation (Orellano et al. 2017).

11. The main anthropogenic sources of PM are traffic and transportation, and combustion processes. Nitrogen dioxide and carbon monoxide are principally emitted from fossil fuel combustion in urban environments. Ozone is a secondary pollutant formed by photochemical reactions between sunlight and pollutant precursors, such as nitrogen oxides and volatile organic compounds (Orellano et al. 2017).
12. Increased pollution exposures have been associated with increased numbers of hospital admissions and emergency-room visits, mainly due to exacerbations of chronic obstructive pulmonary disease and asthma (Orellano et al. 2017).
13. In the atmosphere, different PM sizes can be found. The coarse fraction (PM₁₀ – PM_{2.5}) can penetrate into the upper airways, but the fine fraction (PM_{2.5} - PM₁) can be deposited in the lung, especially in the alveoli, although it could pass to the systemic circulation. Besides the size of PM, the chemical composition of particulates are very important to understand the potential health effects (Orellano et al. 2017).

27.2.3 Ground and / or Water Contamination

14. Recreational exposure to natural toxins by skin contact, accidental swallowing of water or inhalation can cause a wide range of acute or chronic illnesses (Koreiviene et al. 2014).
15. Drinking water supplies from both surface water and ground water sources may be contaminated during flooding events (Andrade et al. 2018).
16. Cyanobacteria are ubiquitous photosynthetic micro-organisms forming blooms and scums in surface water; among them some species can produce cyanotoxins giving rise to some concern for human health (Testai et al. 2016).
17. The safety of water supplies is of paramount public health importance. Although microbiological contamination is the largest contribution to waterborne disease and mortality at a global scale, chemical contaminants in water supplies also can cause disease, sometimes after long periods of exposure. Water supplies often include mixtures of chemical contaminants that vary in time and space. However, drinking-water quality is regulated and monitoring must be conducted routinely.

27.2.4 Physical Activity

18. There is strong evidence that active travel (such as walking or cycling) can result in substantial health benefits (Winters et al. 2017). Engagement in leisure activities is also associated with increased subjective well-being (Kuykendall et al. 2015) and decreased risk of type 2 diabetes (Huai et al. 2016).

19. Natural environments such as green or open spaces, but also attractive views of nature integrated within the urban landscape, are important environmental factors sustaining physical activity in the population (Calogiuri and Chroni 2014).
20. An activity friendly neighbourhood that is walkable, dense, accessible, equipped with walk/cycle facilities and safe from traffic is associated with more active transportation to school in children (D'Haese et al. 2015).
21. Physical activity can improve mental health; the strongest evidence indicates that this is through improvements in physical self-perceptions that accompanied enhanced self-esteem (Lubans et al. 2016).
22. Anxiety symptoms (below the threshold of anxiety disorders) are common in older adults (65 year and over). Regular physical activity may be effective for improving anxiety symptoms in older adults (Mochcovitch et al. 2016).
23. Nearly half of people aged over 60 years are inactive. Access difficulties (environmental barriers or affordability) are one of the barriers to physical activity participation amongst older people (Franco et al. 2015).

27.2.5 Journey Times and / or Reduced Access

24. Areas with greater access to primary health care have lower hospitalization rates for ambulatory care sensitive conditions (conditions which are potentially avoidable by well-functioning primary care) (Rosano et al. 2013).
25. Transportation barriers are often cited as barriers to healthcare access. Transportation barriers lead to rescheduled or missed appointments, delayed care, and missed or delayed medication use. These consequences may lead to poorer management of chronic illness and thus poorer health outcomes (Syed et al. 2013).
26. 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).
27. When patients cannot get to their health care provider, they miss the opportunity for evaluation and treatment of chronic disease states, changes to treatment regimens, escalation or de-escalation of care and, as a result, delay interventions that may reduce or prevent complications (Syed et al. 2013).
28. Lack of access to transport can mean the difference between care delivered in a timely manner that has a greater chance of improved health outcomes and an inefficient utilisation of health care services. This may be late, or non-, presentation

at primary health care and a higher level of treatment in accident and emergency departments (Syed et al. 2013).

29. Shortages of sufficient health care in rural areas relate to staff shortages, uneven distribution of resources, quality deficiencies, access limitations and the inefficient utilisation of health care services. The reasons for such shortages include physical/infrastructural, professional, educational, social-cultural, economic and political issues (Weinhold and Gurtner 2014).

27.2.6 Employment

30. Employment is beneficial for health, particularly in having a protective effect on depression and general mental health (van der Noordt et al. 2014).

31. Unemployment is not only an effect of illness, but also a cause of it. The long-term unemployed carry a markedly higher burden of disease, particularly mental illness, compared to employed persons and those who are unemployed only for a short time (Herbig et al. 2013). Negative health effects are associated with unemployment linked to socioeconomic status (manual workers suffer more) and being unemployed due to health reasons (Norstrom et al. 2014).

32. Job insecurity can pose as great a threat to health and mental health as unemployment. Job insecurity constitutes a chronic stressor which does not immediately affect health, but its impact intensifies over the period that jobs are perceived to be at risk (Kim and von dem Knesebeck 2015).

33. Low socio-economic status is associated with higher risk factors for non-communicable diseases, such as increased risk of mortality from lung cancer, chronic obstructive pulmonary disease, and reduced breast cancer survival (Sommer et al. 2015).

27.2.7 Electromagnetic Fields

34. There is a growing body of literature indicating there is no causal relationship between exposure to Electro Magnetic Fields (EMF) and subjective well-being in members of the public whether or not they report perceived sensitivity to EMFs (Eltiti et al. 2015).

35. High Voltage Direct Current (HVDC) lines transport large amounts of energy over long distances. The operation of these lines produces static electric fields. Humans are able to perceive the presence of static electric fields at sufficiently high levels due to superficial sensory stimulation of hair and skin. Consistent with other reviews, including by the World Health Organisation (WHO) and specifically in the UK, the evidence does not indicate that static electric fields have adverse health effects (Petri et al. 2017).

36. As a consequence of their design, some types of equipment do not produce an external electric field. This applies to underground cables and Gas Insulated Switchgear (GIS), which are enclosed in a metal sheath (a protective metal layer within the cable) and have solid metal enclosures respectively.
37. In the East Anglia TWO Scoping Opinion (Planning Inspectorate 2017), Public Health England (PHE) note that the evidence to date suggests that in general, there are no adverse effects on the health of the UK population caused by exposure to extremely low frequency electromagnetic fields below the guideline levels. The scientific evidence, as reviewed by PHE, supports the view that precautionary measures should address solely the possible association with childhood leukaemia and not other more speculative health effects. The measures should be proportionate in that overall benefits outweigh the fiscal and social costs, have a convincing evidence base to show that they will be successful in reducing exposure, and be effective in providing reassurance to the public.

27.3 References

- Andrade, I., O'dwyer, J., O'Neill, E. & Hynds, P. (2018) Surface water flooding, groundwater contamination and enteric disease in developed countries: A scoping review of connections and consequences. *Environ Pollut*, 236, 540-549.
- Basner, M., Babisch, W., Davis, A., Brink, M., Clark, C., Janssen, S. & Stansfeld, S. (2014) Auditory and non-auditory effects of noise on health. *Lancet*, 383, 1325-1332.
- Calogiuri, G. & Chroni, S. (2014) The impact of the natural environment on the promotion of active living: An integrative systematic review. *BMC Public Health*, 14, 873.
- D'haese, S., Vanwolleghem, G., Hinckson, E., De Bourdeaudhuij, I., Deforche, B., Van Dyck, D. & Cardon, G. (2015) Cross-continental comparison of the association between the physical environment and active transportation in children: a systematic review. *The International Journal of Behavioral Nutrition and Physical Activity*, 12, 145.
- Eltiti, S., Wallace, D., Russo, R. & Fox, E. (2015) Aggregated data from two double-blind base station provocation studies comparing individuals with idiopathic environmental intolerance with attribution to electromagnetic fields and controls. *Bioelectromagnetics*, 36, 96-107. <https://doi.org/10.1002/bem.21892>
- Franco, M. R., Tong, A., Howard, K., Sherrington, C., Ferreira, P. H., Pinto, R. Z. & Ferreira, M. L. (2015) Older people's perspectives on participation in physical activity: a systematic review and thematic synthesis of qualitative literature. *Br J Sports Med*, 49, 1268-76.
- Herbig, B., Dragano, N. & Angerer, P. (2013) Health in the long-term unemployed. *Dtsch Arztebl Int*, 110, 413-9.
- Huai, P., Han, H., Reilly, K. H., Guo, X., Zhang, J. & Xu, A. (2016) Leisure-time physical activity and risk of type 2 diabetes: a meta-analysis of prospective cohort studies. *Endocrine*, 52, 226-30.
- Kim, T. J. & Von Dem Knesebeck, O. (2015) Is an insecure job better for health than having no job at all? A systematic review of studies investigating the health-related risks of both job insecurity and unemployment. *BMC Public Health*, 15, 985.
- Koreiviene, J., Anne, O., Kasperoviciene, J. & Burskyte, V. (2014) Cyanotoxin management and human health risk mitigation in recreational waters. *Environ Monit Assess*, 186, 4443-59.
- Kuykendall, L., Tay, L. & Ng, V. (2015) Leisure engagement and subjective well-being: A meta-analysis. *Psychol Bull*, 141, 364-403.

Lubans, D., Richards, J., Hillman, C., Faulkner, G., Beauchamp, M., Nilsson, M., Kelly, P., Smith, J., Raine, L. & Biddle, S. (2016) Physical Activity for Cognitive and Mental Health in Youth: A Systematic Review of Mechanisms. *Pediatrics*, 138.

Meo, S. A. & Suraya, F. (2015) Effect of environmental air pollution on cardiovascular diseases. *Eur Rev Med Pharmacol Sci*, 19, 4890-7.

Mochcovitch, M. D., Deslandes, A. C., Freire, R. C., Garcia, R. F. & Nardi, A. E. (2016) The effects of regular physical activity on anxiety symptoms in healthy older adults: a systematic review. *Rev Bras Psiquiatr*, 38, 255-61.

Norstrom, F., Virtanen, P., Hammarstrom, A., Gustafsson, P. E. & Janlert, U. (2014) How does unemployment affect self-assessed health? A systematic review focusing on subgroup effects. *BMC Public Health*, 14, 1310.

Orellano, P., Quaranta, N., Reynoso, J., Balbi, B. & Vasquez, J. (2017) Effect of outdoor air pollution on asthma exacerbations in children and adults: Systematic review and multilevel meta-analysis. *PLoS One*, 12, e0174050.

Petri, A. K., Schmiedchen, K., Stunder, D., Dechent, D., Kraus, T., Bailey, W. H. & Driessen, S. (2017) Biological effects of exposure to static electric fields in humans and vertebrates: a systematic review. *Environ Health*, 16, 41. <https://doi.org/10.1186/s12940-017-0248-y>

Rosano, A., Loha, C. A., Falvo, R., van der Zee, J., Ricciardi, W., Guasticchi, G. & de Belvis, A. G. (2013) The relationship between avoidable hospitalization and accessibility to primary care: a systematic review. *Eur J Public Health*, 23, 356-60. <https://doi.org/10.1093/eurpub/cks053>

Sommer, I., Griebler, U., Mahlknecht, P., Thaler, K., Bouskill, K., Gartlehner, G. & Mendis, S. (2015). Socioeconomic inequalities in non-communicable diseases and their risk factors: an overview of systematic reviews. *BMC Public Health*, 15, 914.

Syed, S. T., Gerber, B. S. & Sharp, L. K. (2013) Traveling towards disease: transportation barriers to health care access. *J Community Health*, 38, 976-93.

Testai, E., Scardala, S., Vichi, S., Buratti, F. M. & Funari, E. (2016) Risk to human health associated with the environmental occurrence of cyanobacterial neurotoxic alkaloids anatoxins and saxitoxins. *Crit Rev Toxicol*, 46, 385-419.

Van der Noordt, M., H. I. J., Droomers, M. & Proper, K. I. (2014) Health effects of employment: a systematic review of prospective studies. *Occup Environ Med*, 71, 730-6.

Van Kamp, I. & Davies, H. (2013) Noise and health in vulnerable groups: a review. *Noise Health*, 15, 153-9.

Weinhold, I. & Gurtner, S. (2014) Understanding shortages of sufficient health care in rural areas. *Health Policy*, 118, 201-14.

Winters, M., Buehler, R. & Gotschi, T. (2017) Policies to Promote Active Travel: Evidence from Reviews of the Literature. *Curr Environ Health Rep*, 4, 278-285.