Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects

Appendix 3 - Assessment of Sea Bed Disturbance Impacts from Unexploded Ordnance Clearance

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Glossary of Acronyms

AoO	Advice on Operations
CSBC	Cromer Shoal Chalk Beds
DEP	Dudgeon Offshore Wind Farm Extension Project
DOW	Dudgeon Offshore Wind Farm
ES	Environmental Statement
ETG	Expert Topic Group
EUNIS	European Nature Information System
km	Kilometre
MCZ	Marine Conservation Zone
ML	Marine Licence
NEQ	Net Explosive Quantity
SACO	Supplementary Advice on Conservation Objectives
SEP	Sheringham Shoal Offshore Wind Farm Extension Project
SOW	Sheringham Offshore Wind Farm
TNT	Trinitrotoluene
UXO	Unexploded Ordnance

Glossary of Terms

Dudgeon Offshore Wind Farm Extension Project (DEP)	The Dudgeon Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
Landfall	The point at the coastline at which the offshore export cables are brought onshore, connecting to the onshore cables at the transition joint bay above mean high water.
Offshore export cable corridor	This is the area which will contain the offshore export cables between offshore substation platform/s and landfall, including the adjacent Offshore Temporary Works Area.
Sheringham Shoal Offshore Wind Farm Extension Project (SEP)	The Sheringham Shoal Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.

3. APPENDIX 3 ASSESSMENT OF SEA BED DISTURBANCE IMPACTS FROM UNEXPLODED ORDNANCE CLEARANCE

3.1 Introduction

1. This appendix provides an assessment of potential sea bed disturbance impacts on the Cromer Shoal Chalk Beds (CSCB) Marine Conservation Zone (MCZ) from Unexploded Ordnance (UXO) clearance at the Sheringham Shoal Offshore Wind Farm Extension Project (SEP) and the Dudgeon Offshore Wind Farm Extension Project (DEP). The offshore export cable corridor traverses the CSCB MCZ with up to approximately 11km of offshore export cable corridor within the CSCB MCZ. Within the offshore export cable corridor there may be UXO devices present. UXO devices will be avoided as far as possible through micro-siting of the offshore export cable corridor, vessel anchors and jack-up vessel legs. While any identified UXO will either be avoided or removed and disposed of onshore in a designated facility, there is the potential that underwater detonation could be required where it is unsafe to remove the UXO. Where they are required to be detonated in the subsea area, low order detonation techniques, where possible, will be preferred.
2. As agreed at the marine mammals Expert Topic Group (ETG) meeting on the 20th July 2021, UXO clearance will be assessed as part of a separate Marine Licence (ML) application to be submitted post-consent once greater detail on the locations and number of UXO to be cleared is known. This assessment has therefore been provided for information purposes only in response to stakeholder comments (see **Section 4** of the **CSCB MCZ Assessment Stage 1 Report** (document reference 5.6)).

3.2 Background

3. A detailed UXO survey will be completed prior to construction. Therefore, the number of possible UXO that may require to be cleared is unknown at this time.
4. At Sheringham Offshore Wind Farm (SOW), just one UXO was found, out of a potential 52 targets investigated, that was required to be cleared prior to construction; a German air dropped bomb of 250lbs (113kg) (Scira Offshore Energy, 2010).
5. For Dudgeon Offshore Wind Farm (DOW), a total of 243 targets were identified as potential UXO targets for further investigation. Of those, 20 were identified as UXO requiring clearance (11 of which were in the offshore export cable corridor), in addition to three partial UXO that would also require clearance. The UXO cleared at DOW included one 2,000lb (907kg), three 1,000lb (454kg), six 500lb (227kg), and two 250lb (113kg) German air dropped bombs, seven 6 inch projectiles (of 45kg), one Mk17 mine, and two mine sinkers (Statoil, 2015).
6. At Hornsea Project Two, similar UXO to those found at DOW were identified, with a total of 38 UXO confirmed within the project area, ranging from 2,000lb (907kg), 1,000lb (454kg), 500lb (227kg), and 50kg air-delivered bombs, Mk17 mines, 12 inch projectiles, and German land mines (Orsted, 2019).

7. These UXO weights have been converted from lb to kg for consistency, however, this is not the same as the Net Explosive Quantity (NEQ) or trinitrotoluene (TNT) equivalent weights used in the assessment.

8. The following assessment is based on a single detonation of the worst-case / largest size UXO device of 700kg NEQ. Since the number of UXO required to be cleared is unknown, and a detailed assessment will be undertaken based on the actual number and size of UXO to be cleared at that time, the current assessment is considered appropriate. The assessment is based on the worst-case for a high-order UXO detonation with no mitigation, which is highly unlikely, as the preferred and first option for any UXO requiring detonation would be a low-order clearance method which is likely to result in a much lower sea bed disturbance footprint.

9. The footprint of craters created by detonation of UXO devices was estimated by Ordtek (2018), this report states that *"there is very limited open-source information available on crater sizes produced by detonations underwater and we are not aware of any comprehensive figures, tables or research on this subject".* The Ordtek (2018) report presents estimates of theoretical crater sizes for the Norfolk Vanguard project for a range of UXO charge sizes, using two different methods and compares those results with field observations of craters resulting from UXO clearance at offshore wind farms. The Norfolk Vanguard project, located approximately 59km from the MCZ at its nearest point, has broadly similar sea bed sediment conditions to the part of the MCZ through which the SEP and DEP offshore export cable corridor transits. The UXO in that area is of the type likely to be encountered anywhere in the southern North Sea. Therefore, this report is considered relevant and likely to be the best available evidence of the effects of UXO detonation on the sea bed.

10. In the Environmental Statement (ES), various UXO charge weight sizes are assessed with a maximum of 525kg NEQ (see **Table 10-2** of **Chapter 10 Marine Mammal Ecology**). Ordtek (2018) use a maximum of 700kg NEQ device in their estimates for crater footprint (thus providing a precautionary assessment for SEP and DEP), which gives a crater diameter of 21m[1] (giving an area of approximately 346m^2 per crater).

3.3 Temporary Habitat Loss / Physical Disturbance from UXO Clearance

11. Temporary habitat loss and physical disturbance would occur as a result of UXO clearance activities. Three broadscale marine habitat features and one geological feature have the potential to be affected by temporary habitat loss and physical disturbance during UXO clearance:

- Subtidal coarse sediment (A5.1);
- Subtidal sand (A5.2);
- Subtidal mixed sediments (A5.4); and
- North Norfolk Coast assemblage of subtidal sediment features and habitats.

[1] For the purposes of this assessment the worst-case estimate (i.e. Table 7.1 in Ordtek, 2018) has been used rather than field observations as the field observations data were from smaller devices than 700kg NEQ

12. The impact of temporary habitat loss and physical disturbance from UXO clearance has been defined using the following pressures identified by Natural England's Advice on Operations (AoO) for the CSCB MCZ:
    - Abrasion/disturbance of the substrate on the surface of the sea bed; and
    - Penetration and/or disturbance of the substratum below the surface of the sea bed, including abrasion.

13. The remainder of this section assesses the impact of temporary habitat loss and physical disturbance from UXO clearance against the attributes and targets of each protected feature as provided by Natural England's Supplementary Advice on Conservation Objectives (SACOs).

3.3.1 Physical Attributes

14. The following physical attributes of protected features are relevant to temporary habitat loss and physical disturbance impacts:
    - Extent and distribution
    - Structure: sediment composition and distribution

15. As discussed, the worst-case maximum area of sea bed within the CSCB MCZ which could be impacted during UXO clearance of one 700kg NEQ device would be 346m^2. **Table 1** provides the extent of CSCB MCZ features that will be potentially impacted by temporary habitat loss and physical disturbance from UXO clearance.

Table 1: Footprint of UXO Clearance within the MCZ

Protected feature	Spatial extents	Potential Area Impacted
High energy circalittoral rock (A4.1)	30km^2	N/A
Moderate energy circalittoral rock (A4.2)		N/A
High energy infralittoral rock (A3.1)	0km^2	N/A
Moderate energy infralittoral rock (A3.2)	0km^2	N/A
Subtidal coarse sediment (A5.1)	148km^2	346m^2
Subtidal mixed sediments (A5.4)	49km^2	346m^2
Subtidal sand (A5.2)	18km^2	346m^2
Peat and clay exposures	60 points records	N/A
Subtidal chalk	30km^2	N/A

Protected feature	Spatial extents	Potential Area Impacted
North Norfolk Coast Assemblage of Subtidal Sediment Features and Habitats (subtidal)	Combination of extents above	346m^2
CSCB MCZ	321km^2	346m^2

16. As a worst-case, up to 0.00002% of the subtidal sand feature of the CSCB MCZ could be disturbed by detonation of a single 700kg NEQ UXO device.

3.3.2 Biological Attributes

17. The following biological attributes of protected features are relevant to temporary habitat loss and physical disturbance from UXO clearance:
    - Distribution - presence and spatial distribution of biological communities;
    - Structure and function: presence and abundance of key structural and influential species; and
    - Structure: species composition of component communities.

18. Temporary habitat loss and physical disturbance from UXO clearance would result in localised mortality of macrofauna and likely reductions in species richness and biomass.

3.3.2.1 Subtidal coarse sediment (A5.1)

19. Areas of subtidal coarse sediment in the offshore export cable corridor were defined to European Nature Information System (EUNIS) level 4 as A5.13 Infralittoral coarse sediment in some areas but not to the biotope level. Natural England's AoO identifies five biotopes that may be represented within this feature. Their sensitivity to relevant pressures ranges from Not Sensitive to Medium, with the highest sensitivity being to penetration or removal of substratum (extraction) and disturbance of the substratum subsurface (both medium sensitivity) (**Appendix 2 CSCB MCZ Biotope Sensitivity Ranges** (document reference 5.6.2)). Resilience ranges from medium to high, equating to full recovery within 2-10 years or within 2 years respectively.

3.3.2.2 Subtidal sand (A5.2)

20. Areas of subtidal sand in the offshore export cable corridor were identified as including the biotope complex A5.23 Infralittoral fine sand and the biotope A5.233 *Nephtys cirrosa* and Bathyporeia spp. in infralittoral sand. The sensitivity of this biotope to relevant pressures ranges from Low to Medium, with the highest sensitivity being to penetration or removal of substratum (extraction). Sensitivity to abrasion / disturbance of the substrate on the surface of the sea bed and disturbance of the substratum subsurface is Low (**Appendix 2 CSCB MCZ Biotope Sensitivity Ranges** (document reference 5.6.2)). Resilience to all pressures is high with full recovery within 2 years.

3.3.2.3 Subtidal mixed sediments (A5.4)

21. Areas of mixed sediments in the offshore export cable corridor were classified as the biotope complex 'Infralittoral mixed sediment' (A5.43), showing similarities to the biotope '*Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment' (A5.431) mixed with areas of the biotope '*Sabellaria spinulosa* on stable circalittoral mixed sediment' (A5.611). The sensitivity of these biotopes to relevant pressures ranges from Low to Medium. These biotopes are not listed under AoO as representative of the CSCB MCZ subtidal mixed sediments feature. However, all biotopes listed against the feature have Medium sensitivity to relevant pressures with medium resilience, equating to full recovery within 2-10 years.

3.3.3 Summary

22. UXO devices will be avoided as far as possible and where they are required to be detonated in the subsea area, low order detonation techniques, where possible, will be preferred.

23. The dynamic nature of the sediment in this area means that any direct changes to the sea bed elevation associated with craters are likely to recover over a short period of time due to natural sediment transport pathways. Therefore, the extent, distribution and structure of these habitat features will not change as a result of temporary habitat loss and physical disturbance. The presence and spatial distribution of associated biological communities will be maintained despite potentially some localised mortality of macrofauna and reductions in species richness and biomass in the disturbed areas, representing a worst-case 0.00002% of the subtidal sand feature of the CSCB MCZ. Recovery of these communities will take place rapidly with full recovery expected within two years in many areas based on the resilience of most biotopes. Recovery may take longer in some coarse and mixed sediment areas but based on DOW post-construction monitoring of cable installation activities, full recovery is expected in less than four years (MMT, 2019).

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