Hornsea Project Three
Offshore Wind Farm

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Offshore Wind Farm

Preliminary Environmental Information Report:
Annex 2.3 - Marine Conservation Zone Assessment

Date: July 2017

Hornsea 3
Offshore Wind Farm

DONG
energy

Environmental Impact Assessment

Preliminary Environmental Information Report

Volume 5

Annex 2.3 – Marine Conservation Zone Assessment

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Glossary

Term	Definition
Benthic ecology	Benthic ecology encompasses the study of the organisms living in and on the sea floor, the interactions between them and impacts on the surrounding environment.
Biotope	The combination of physical environment (habitat) and its distinctive assemblage of conspicuous species.
Circalittoral	The subzone of the rocky sublittoral below that dominated by algae (i.e. the infralittoral), and dominated by animals.
Epibenthic	Organisms living on the surface of the seabed.
Epifauna	Animals living on the surface of the seabed.
Infauna	The animals living in the sediments of the seabed.
Infralittoral	A subzone of the sublittoral in which upward-facing rocks are dominated by erect algae.
Polychaete	A class of segmented worms often known as bristleworms.
Scour	Local erosion of sediments caused by local flow acceleration around an obstacle and associated turbulence enhancement.
Sessile	Organisms which are immobile or fixed to the substrate.
Sublittoral	Area extending seaward of low tide to the edge of the continental shelf.
Subtidal	Area extending from below low tide to the edge of the continental shelf.

Acronyms

Acronym	Description
CPA	Coast Protection Act 1949
DCO	Development Consent Order
DMRB	Design Manual for Roads and Bridges
FEPA	Food and Environmental Protection Act 1985
FOCI	Feature of Conservation Interest
IMO	International Maritime Organisation
INNS	Invasive and Non-Native Species
MCAA	Marine and Coastal Access Act
MCZ	Marine Conservation Zone
MMO	Marine Management Organisation
MPA	Marine Protected Areas
PEIR	Preliminary Environmental Information Report
PEMMP	Project Environmental Management and Monitoring Plan
rMCZ	Recommended Marine Conservation Zone
SNCB	Statutory Nature Conservation Bodies
SAD	Site Assessment Document
SSC	Suspended Solids Concentrations
SoS	Secretary of State
VER	Valued Ecological Receptor

Units

Unit	Description
%	Percent
km	Kilometre
m	Metre
m^2	Metre squared
m^3	Metre Cubed
mg/kg	Milligrams per kilogram

1. Introduction

1.1.1.1 DONG Energy Power (UK) Ltd. (hereafter referred to as DONG Energy), on behalf of DONG Energy Hornsea Project Three (UK) Ltd. is promoting the development of the Hornsea Project Three offshore wind farm (hereafter referred to as Hornsea Three). Hornsea Three is a proposed offshore wind farm project within the former Hornsea Zone, and includes the associated Hornsea Three offshore cable route corridor and onshore infrastructure. The proposal is for an offshore wind farm with a total generating capacity of up to 2,400 MW which will be situated within the Hornsea Three array area in the east of the former Hornsea Zone. Hornsea Three is located in the central region of the North Sea, approximately 121 km from the UK coast (at Tringham, Nofolk) and approximately 10.1 km west of the median line between UK and Netherlands waters.

1.1.1.2 RPS was commissioned to undertake a Marine Conservation Zone (MCZ) assessment for Hornsea Three and this Annex of the Preliminary Environmental Information Report (PEIR) provides the findings to date of the Shadow MCZ Assessment for Hornsea Three. It should be noted that the Hornsea Three project is in the process of progressing the MCZ Assessment and is working with relevant stakeholders (see section 1.2) to achieve this aim. It is acknowledged that there are elements of the MCZ assessment which are outstanding and therefore we are not yet at the end of the process. During and after PEIR consultation, Hornsea Three will continue to engage with the relevant stakeholders to ensure a robust Shadow MCZ Assessment is produced. The final Shadow MCZ Assessment (to be submitted with the Development Consent Order (DCO) application) is intended to provide the information to inform an assessment required to be undertaken in due course by the Secretary of State (SoS).

1.1.1.3 Specific consideration of MCZs is required for any marine licence or DCO applications in English or UK waters. Under section 126 of the Marine and Coastal Access Act (2009) (MCAA), public authorities (i.e. the Marine Management Organisation (MMO) for marine licence applications or the SoS for DCO applications) have specific duties for MCZs. s.126 applies where:

- (a) A public authority has the function of determining an application (whenever made) for authorisation of the doing of an act, and
- (b) The act is capable of affecting (other than insignificantly):
  - (i) The protected features of an MCZ;
  - (ii) Any ecological or geomorphological process on which the conservation of any protected feature of an MCZ is (wholly or in part) dependent.

1.1.1.4 This report has been produced to provide the necessary evidence on the impacts of Hornsea Three on three identified MCZs. This document follows guidance published by the MMO (2013) on how these assessments should be undertaken. The Shadow MCZ assessment has been undertaken on the basis of the Hornsea Three information detailed within volume 1 Chapter 3: Project Description.

1.1.1.5 This Shadow MCZ assessment should be read alongside the following chapters of the PEIR, all of which have been drawn upon and referred to throughout this document:

- Volume 5, annex 2.1: Benthic Ecology Technical Report;
- Volume 2, chapter 2: Benthic Ecology;
- Volume 5, annex 1.1: Marine Processes Technical Report; and
- Volume 2, chapter 1: Marine Processes.

1.1.1.6 This report is structured as follows:

- Section 1: Introduction
- Section 2: Methodology, including description of the staged approach to the MCZ assessment following the relevant published guidelines, and how information presented in other parts of the PEIR have been used to support the assessments presented herein;
- Section 3: Screening of MCZs and recommended MCZs (rMCZ) which have the potential to be affected by Hornsea Three;
- Section 4: Background information on MCZs and rMCZs to be considered in Shadow MCZ assessment;
- Section 5: Stage 1 Assessment; and
- Section 6: Next steps.

1.2 Consultation

1.2.1.1 The MCZ assessment has been informed by consultation with key stakeholders, including the MMO, Natural England, The Wildlife Trusts (TWT) and the Planning Inspectorate (PINS), through the Hornsea Three MCZ Working Group. Prior to PEIR submission, two MCZ Workshops have been undertaken, one in February 2017 and the second in May 2017. During the second of these workshops, the methodology used in this MCZ assessment (see section 2) was presented to the MCZ Working Group for discussion. Natural England highlighted that the methodology employed should be amended to assess each protected feature individually with consideration of attributes and targets for those protected features of the MCZ (see Appendix A). Natural England highlighted that this approach would be clearer following issue of the conservation objectives for the Cromer Shoal Chalk Beds MCZ. Due to the unavailability of such advice at the time of PEIR production, it was suggested by Natural England, that the conservation objectives for the Thanet Coast MCZ (and others) could be used as a ‘proxy’ for the Cromer Shoal Chalk Beds MCZ in the absence of conservation objectives for this site.

1.2.1.2 This feedback was received when the MCZ assessment had been drafted and therefore it has not been possible to re-draft all assessments for both the Cromer Shoal and Markham's Triangle MCZs following the advice provided by Natural England. In order to demonstrate how the assessment could be restructured for the final DCO submission in accordance with advice provided by Natural England (and drawing on the conservation objectives for the Thanet Coast MCZ), an example of this approach has been presented within Appendix A for one of the assessments (i.e. *cable installation within the Cromer Shoal Chalk Beds MCZ leading to habitat loss/disturbance*') considered in the Stage 1 assessment. All other assessments presented within the main part of this report are undertaken using the original Hornsea Three methodology and has therefore not taken into account the Natural England advice. It should be noted that although the structure and presentation of information in the Shadow MCZ Assessment will change for the final application, the information underpinning the assessment presented in this report provides a robust assessment on the relevant protected features of the MCZ and is considered appropriate for informing the Section 42 consultation process. All additional information relating to the MCZ assessment, which becomes available during and following Section 42 consultation, will be discussed with stakeholders in further MCZ Workshops and considered within the final application, where relevant.

2. Methodology

2.1.1.1 Guidance published by the MMO (2013) indicates how MCZ assessments can be undertaken in the context of marine licensing decisions. These MMO guidelines recommend a staged approach to the assessment, with three sequential stages: Screening, Stage 1 Assessment and Stage 2 Assessment (see Figure 2.1). Full details of each of these stages of the approach have been provided in the following sections.

2.1.1.2 If certain activities, sites or impacts are screened into the MCZ assessment process, these are then considered within the Stage 1 Assessment, followed by a Stage 2 Assessment if significant risks to the achievement of the MCZ conservation objectives have been identified in the Stage 1 Assessment.

2.1.1.3 This assessment has considered MCZs that have been designated during the first two tranches of MCZ designations (Tranche One in 2013 and Tranche Two in 2016). For the purposes of this assessment, rMCZs have also been considered where these have the potential to be brought forward during the process of consenting for Hornsea Three (i.e. Tranche Three expected to be designated in 2018).

2.2 Screening

2.2.1.1 According to the MMO (2013) guidelines, all marine licence applications need to be screened to determine whether s.126 should apply to the application. It would apply if it is determined through the course of screening that:

- The licensable activity is taking place within or near an area being put forward or already designated as an MCZ; and
- The activity is capable of affecting (other than insignificantly) either (i) the protected features of an MCZ; or (ii) any ecological or geomorphological process on which the conservation of any protected feature of an MCZ is (wholly or in part) dependant.

2.2.1.2 The MMO recommends the use of a risk based approach when determining the "nearness" of an activity to MCZs, including applying an appropriate buffer zone to the MCZ protected features under consideration as well as a consideration of risks for activities at greater distances from protected features of the MCZ(s).

2.2.1.3 In determining "insignificance", the MMO considers the likelihood of an activity causing an effect, the magnitude of the effect should it occur, and the potential risk any such effect may cause on either the protected features of an MCZ or any ecological or geomorphological process on which the conservation of any protected feature of an MCZ is (wholly or in part) dependant.

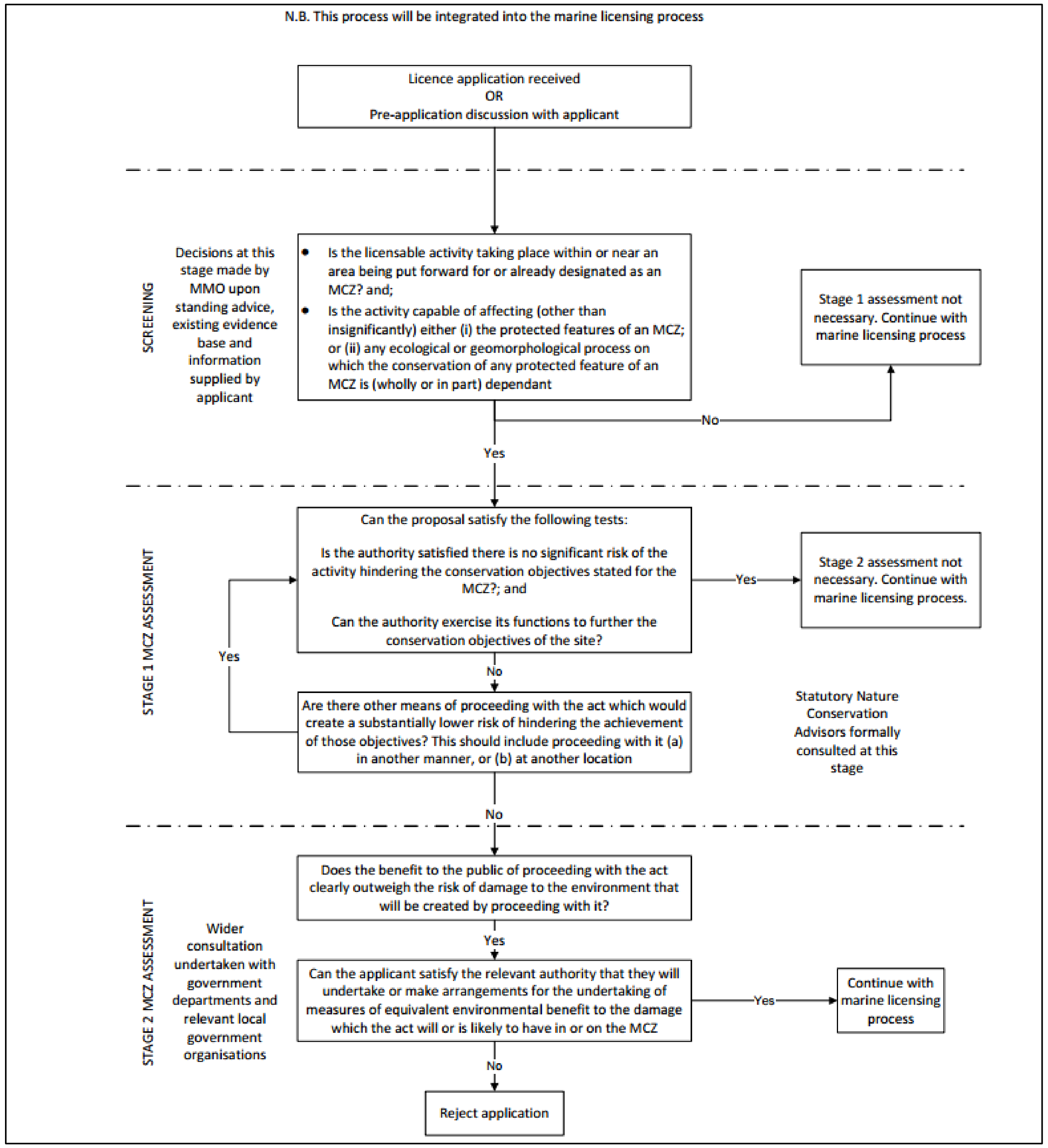

Figure 2.1: Flow chart summary of the MCZ assessment process used by the MMO during marine licence determination (MMO, 2013).

2.2.1.4 For the purposes of the Hornsea Three MCZ Screening, MCZs and rMCZs considered within the assessment were identified through the Scoping Report (DONG Energy, 2016) and the Benthic Ecology impact assessment (see volume 2, chapter 2: Benthic Ecology). This initial screening identified designated sites (including MCZs and rMCZs) on the basis of proximity to Hornsea Three, as follows:

- Sites which overlap with Hornsea Three; and
- Sites with relevant protected features located within one tidal excursion (approximately 12 km) of the Hornsea Three array area and/or offshore cable corridor.

2.2.1.5 Following identification of the MCZs and rMCZs considered in this initial screening, information presented within the PEIR was reviewed to further refine this list of sites to those with the potential to be affected by Hornsea Three. This included review of outputs from Volume 2, Chapter 1: Marine Processes to identify potential far field effects (e.g. increases in suspended sediment concentrations, or SSC, and changes to the tidal and wave regime due to the operational Hornsea Three offshore wind farm). Where robust evidence was available to screen out MCZs or rMCZs, this evidence has been referenced and justification presented within section 3.

2.2.1.6 Individual impacts on designated protected features of the MCZs and rMCZs were also considered in the screening. Impacts identified in Volume 2, Chapter 2: Benthic Ecology as having negligible significance were considered to be of sufficiently low risk of resulting in a significant effect on protected features and have therefore been screened out i.e. were considered insignificant. This may have been due, for example, to the extremely limited extent and/or duration of the impact, a lack of sensitivity of the receptors to the impact, or due to control measures to be implemented for the project duration to minimise the risk of any impact occurring.

2.3 Stage 1 Assessment

2.3.1.1 The stage 1 assessment (if/as required) would then consider whether the conditions in s.126(6) can be met, namely is the decision-maker satisfied there is no significant risk of the activity hindering the achievement of the conservation objectives stated for the MCZ. In doing so the MMO guidelines suggest the decision-maker would use the information supplied by the applicant with the licence application, advice from the Statutory Nature Conservation Bodies (SNCBs) and any other relevant information. to determine whether:

- There is no significant risk of the activity hindering the achievement of the conservation objectives stated for the MCZ.

2.3.1.2 If the condition in s.126(6) cannot be met the stage 1 assessment would also consider whether the condition in s.126(7)(a) can be met. In doing so the decision-maker would determine whether:

- There is no other means of proceeding with the act which would create a substantially lower risk of hindering the achievement of the conservation objectives stated for the MCZ. This should include proceeding with it (a) in another manner, or (b) at another location.

2.3.1.3 In undertaking a stage 1 assessment the decision-maker would formally consult with SNCBs for a period of 28 days (under sections 126(2) and (3)) unless the SNCB notifies the decision-maker that it need not wait or the decision-maker determines that there is an urgent need to grant authorisation (in accordance with s.126(4)).

2.3.1.4 Within this stage of assessment the MMO advise that "hinder" would be any act that could, either alone or in combination:

- In the case of a conservation objective of "maintain", increase the likelihood that the current status of a protected feature would go downwards (e.g. from favourable to degraded) either immediately or in the future (i.e. these protected features would be placed on a downward trend); or
- In the case of a conservation objective of "recover", decrease the likelihood that the current status of a protected feature could move upwards (e.g. from degraded to favourable) either immediately or in the future (i.e. these protected features would be placed on a flat or downward trend).

2.3.1.5 When considering whether an activity may hinder the conservation objectives of a site, consideration should be given to the direct impact of an activity upon a protected feature as well as any applicable indirect impacts. Such an indirect impact could include changing the effectiveness of a management measure put in place to further the conservation objectives.

2.3.1.6 The applicant should be able to demonstrate that any "other means" of proceeding reduces the risk such that the act no longer has a significant risk of hindering the conservation objectives of the site.

2.3.1.7 If mitigation to reduce the impacts to an acceptable level cannot be secured, and there are no other alternative locations, then a Stage 2 assessment would be required. Should a Stage 2 assessment be required, this would follow the MMO guidance (MMO, 2013) on the two staged approach for undertaking a MCZ assessment.

2.3.1.8 In determining 'insignificance', the MMO (2013) guidance states "this should take into account the likelihood of an activity causing an effect, the magnitude of the effect should it occur, and the potential risk any such effect may cause on either the protected features of an MCZ or any ecological or geomorphological process on which the conservation of any protected feature of an MCZ is (wholly or in part) dependant." This approach is presented in Hornsea Three's interpretation of the MMO (2013) guidance as outlined in the following section.

2.4 Significance of effects

2.4.1.1 Volume 2, chapter 1: Marine Processes and volume 2, chapter 2: Benthic Ecology of the PEIR have presented assessments of the impacts of Hornsea Three on the physical and ecological marine environment respectively, with definitions of impact, effect and significance of effects on the identified receptors (including protected features of MCZs) drawn from guidelines published in the Design Manual for Roads and Bridges (DMRB) (Highways Agency, 2008). These definitions have also been used within this Shadow MCZ assessment, with the term 'effect' to express the consequence of an impact. This is expressed as the 'significance of effect' and is determined by considering the magnitude of the impact alongside the importance, or sensitivity, of the receptor or resource, in accordance with defined significance criteria.

2.4.1.2 In addition to the DMRB guidelines, consideration has also given to the following guidelines, particularly with respect to effects on benthic ecology:

- Guidelines for Ecological Impact Assessment in the UK and Ireland. Terrestrial, Freshwater and Coastal (CIEEM, 2016);
- Offshore Wind Farms. Guidance note for Environmental Impact Assessment (EIA) in respect of the Food and Environmental Protection Act 1985 (FEPA) and the Coast Protection Act 1949 (CPA) requirements (Cefas *et al*., 2004); and
- Guidance on Environmental Considerations for Offshore Wind Farm Development (OSPAR, 2008).

2.4.1.3 According to these guidelines and the DMRB, the significance of effect on a defined receptor is defined by both the magnitude of the impact and the sensitivity of the receptor.

2.4.2 Magnitude of impact

2.4.2.1 For each impact a magnitude has been assigned, providing a definition of the spatial extent, duration, frequency and reversibility of the impact considered, where applicable.

2.4.2.2 The magnitude of impact has been categorised according to the following scale, with definitions of these provided in the maximum design scenario tables of volume 2, chapter 1: Marine Processes and of volume 2, chapter 2: Benthic Ecology of the PEIR:

- No change;
- Negligible;
- Minor;
- Moderate; and
- Major.

2.4.3 Sensitivity of receptor

2.4.3.1 For the purpose of the MCZ assessment, receptors have been defined as the protected features of the MCZs that would be affected. The protected features of the MCZs and rMCZs with the potential to be affected by Hornsea Three, and therefore considered within this assessment, correspond to the benthic ecological receptors (i.e. habitats and associated species and assemblages) identified within volume 5, annex 2.1: Benthic Ecology Technical Report and assessed in volume 2, chapter 2: Benthic Ecology. In defining the sensitivity for each receptor, the value or importance is a key consideration, with all protected features of MCZs considered to be of national importance (see volume 2, chapter 2: Benthic Ecology). When considering sensitivity it is also important to consider the vulnerability of the receptor to a given impact, combined with the likely rate of recoverability to pre-impact conditions. Vulnerability is defined (in volume 2, chapter 2: Benthic Ecology, based on the Marine Life Information Network (MarLIN) definition) as the susceptibility of a species or assemblage of species to disturbance, damage or death, from a specific external factor. Recoverability is the ability of the same receptor (e.g. species or assemblage of species) to return to a state close to that which existed before the activity or event which caused the change. For benthic ecology receptors it is dependent on the ability of these benthic species/species assemblages to recover or recruit subject to the extent of disturbance/damage incurred. These definitions have been further discussed in volume 2, chapter 2: Benthic Ecology for benthic ecology receptors, including protected features of MCZs.

2.4.4 Significance of effect

2.4.4.1 The overall significance of an effect has been determined by correlating the magnitude of the impact alongside the sensitivity of the receptor. In order to ensure a transparent and consistent approach, a matrix approach has been adopted following the DMRB (Table 2.1; Highways Agency, 2008). Where a range of significance of effect is presented in Table 2.1, the final assessment for each effect has been based upon expert judgement. This is in line with accepted definitions under general EIA practice (e.g. Highways Agency, 2008; see also volume 2, chapter 2: Benthic Ecology and volume 1, chapter 5: Methodology). This has therefore also been adopted for the purposes of the MCZ assessment under the MCAA definitions, with further consideration of specific conservation objectives for the protected features of the MCZ (where these are made available).

2.4.4.2 For the purposes of this Shadow MCZ assessment, any effects with a significance level of minor or less (pale green in the Table 2.1 matrix below) have been concluded to be not significant in terms of the MCAA. In line with MMO (2013) guidance (see paragraph 2.3.1.8), the conclusion with respect to significance of the effect has considered, the risk of an activity causing an effect, the magnitude of the effect should this occur (see paragraph 2.4.2.1) and the potential risks to either the protected features of the MCZ or any ecological or geomorphological process on which these features are dependent.

Table 2.1: Matrix used for the assessment of the significance of the effect (pale green considered to be not significant).

		Magnitude of impact				
Sensitivity of receptor		***No change***	***Negligible***	***Minor***	***Moderate***	***Major***
	Negligible	Negligible	Negligible	Negligible or minor	Negligible or minor	Minor
	Low	Negligible	Negligible or minor	Negligible or minor	Minor	Minor or moderate
	Medium	Negligible	Negligible or minor	Minor	Moderate	Moderate or major
	High	Negligible	Minor	Minor or moderate	Moderate or major	Major or substantial
	Very high	Negligible	Minor	Moderate or major	Major or substantial	Substantial

2.4.4.3 These criteria have been used to inform the Shadow MCZ assessment, drawing on the findings of the impact assessments presented in the PEIR. However, as discussed in section 2.3, and in contrast to the approach to the EcIA presented in volume 2, chapter 2: Benthic Ecology, the Stage 1 assessment has then considered whether there is a risk that Hornsea Three could hinder the achievement of the current conservation status of protected features and conservation objectives for the MCZs, where these have been made available. This includes assessing the risks in the context of the conservation status of each of the individual MCZ protected features and to the specific management approach which applies to each of the protected features. These conservation objectives and management approaches are detailed in section 4 for the sites and the protected features which have been considered in the Stage 1 assessment.

2.4.4.4 Based on the information presented within this assessment and consideration of the conservation objectives and management approach for the sites and protected features, conclusions have been made with respect to whether the conditions in s.126(6) of the MCAA can be met (see paragraph 2.3.1.1), i.e.:

- There is no significant risk of the activity hindering the achievement of the conservation objectives stated for the MCZ.

2.4.4.5 If it cannot be concluded that there is no significant risk of the activity hindering the achievement of the conservation objectives or the management approach for an MCZ, and that mitigation or consideration of alternative means of proceeding, would not create a substantially lower risk of hindering achievement of the conservation objectives (see paragraphs 2.3.1.6 and 2.3.1.7), a stage 2 assessment would be required. Should this be required for Hornsea Three, the relevant parts of the MMO guidance (MMO, 2013) would again be followed on the staged approach for undertaking a Shadow MCZ assessment (see Figure 2.1).

3. Screening

3.1 MCZ Screening

3.1.1.1 As outlined in paragraph 2.2.1.1, according to the MMO (2013) guidelines, s.126 would apply if it is determined through the course of screening that "*the licensable activity is taking place within or near an area being put forward or already designated as an MCZ.*"

3.1.1.2 The MCZs identified in the Hornsea Three Scoping Report (DONG Energy, 2016) and the Benthic Ecology PEIR chapter (see volume 2, chapter 2: Benthic Ecology) as having the potential to be affected by Hornsea Three are listed below, with the location of these in the context of Hornsea Three shown in Figure 3.1.

- Cromer Shoal Chalk Beds MCZ (overlaps with part of the Hornsea Three offshore cable route corridor search area);
- Markham's Triangle rMCZ (overlaps with part of the Hornsea Three array area); and
- Wash Approach rMCZ (within one tidal excursion of the Hornsea Three offshore cable route corridor search area).

3.1.1.3 These three rMCZ/MCZ sites either overlap with Hornsea Three or in the case of the Wash Approach rMCZ, are within one tidal excursion of the Hornsea Three offshore cable route). These sites, and the impacts upon these, have therefore been considered within this MCZ screening.

3.2 Protected Features Screening

3.2.1.1 As outlined in paragraph 2.2.1.1 and in the MMO (2013) guidelines, following identification of MCZs to be considered, s.126 would apply if it is determined through the course of screening that "*the activity is capable of affecting (other than insignificantly) either (i) the protected features of an MCZ; or (ii) any ecological or geomorphological process on which the conservation of any protected feature of an MCZ is (wholly or in part) dependant*."

3.2.1.2 The protected features of the Wash Approach rMCZ was identified as having the potential to be affected by Hornsea Three in the Hornsea Three Scoping Report (DONG Energy, 2016) and based on the criteria outlined in paragraph 2.2.1.4 has been included due to the site's proximity to the Hornsea Three offshore cable corridor. The Marine Processes assessment (volume 2, chapter 1: Marine Processes) concluded that increases in SSC and associated sediment deposition during cable installation would occur in close proximity to the cable, with the majority of sediments (i.e. sand and gravels) settling on the seabed within a few metres of the cable. Fine sediments would be transported over greater distances, but these would be expected to be near background SSCs within hundreds to a few thousands of metres. Sediment deposition due to cable installation would not be likely to settle to a measurable thickness beyond tens to hundreds of metres from the cable, with the majority of disturbed sediments (i.e. sand and gravels) deposited within a few metres of the cable trench.

3.2.1.3 Due to the distance between the Hornsea Three offshore cable corridor and the Wash Approach rMCZ (i.e. 10.5 km at the closest point; see Figure 3.1) and the limited extent of impacts from cable installation (other Hornsea Three construction, operation and decommissioning activities will be more limited in extent), it can be concluded that there is no potential for a receptor-impact pathway that could result in an effect on the protected features of the Wash Approach rMCZ from Hornsea Three. This rMCZ has therefore been screened out of this Shadow MCZ assessment and has not been considered further.

3.2.1.4 Following the MMO guidelines, any impacts that are concluded to have a negligible significant (i.e. insignificant) impact on benthic ecology receptors (including protected features of the MCZs and rMCZs) can be screened out and not taken through to the stage 1 assessment. Impacts which were concluded to have a negligible impact on protected features of MCZs and rMCZs are considered to present a sufficiently low risk to the protected features of an MCZ or the ecological or geomorphological process on which the conservation of any protected feature of an MCZ is (wholly or in part) dependent, so as to allow these to be screened out at this stage. The following impacts have therefore been screened out and were not considered in the stage 1 assessment:

- Accidental release of pollutants (e.g. from accidental spillage/leakage) during construction, operation and decommissioning phases: Volume 2, chapter 2: Benthic Ecology predicted an impact of negligible significance primarily due to the control measures to be employed during construction, operation and decommissioning which will minimise the risk of any release of pollutants and also minimise the magnitude of such a spill, in the unlikely event of this occurring;
- Maintenance operations during the operational phase, resulting in temporary seabed disturbances: Volume 2, chapter 2: Benthic Ecology predicted an impact of negligible significance due to the short term, temporary nature of the impact, the high recovery potential of the habitats and associated communities affected (see sections 5.1.2 and 5.2.1 for information on sensitivity to temporary habitat loss/disturbance) and the highly limited area of seabed predicted to be affected; and

- Removal of foundations and cable protection during the decommissioning phase, leading to loss of species/habitats colonising these structures: Volume 2, chapter 2: Benthic Ecology predicted an impact of negligible significance and since this impact would not affect protected features of the relevant MCZs, this has not been considered further in this assessment.

3.2.1.5 In addition, the following impact has been screened out for the Cromer Shoal Chalk Beds MCZ, as this impact has the potential to affect receptors within the Hornsea Three array area and immediate vicinity (i.e. within a few km) only (see volume 2, chapter 1: Marine Processes and volume 2, chapter 2: Benthic Ecology) and this MCZ is located over 100 km from the Hornsea Three array area. No receptor-impact pathway for this impact and the Cromer Shoal Chalk Beds MCZ has therefore been identified:

- Alteration of seabed habitats arising from effects on physical processes, including scour effects and changes in the sediment transport and wave regimes resulting in potential effects on benthic ecology.

3.2.1.6 Consultation with Natural England as part of the MCZ Working Group (see section 1.2) indicated that Tranche Three of the MCZ designation process may result in the addition of mussel beds to the list of protected features of the Cromer Shoal Chalk Beds MCZ. The only records of mussel beds within the Cromer Shoal Chalk Beds MCZ are in the south of the MCZ near Sea Palling (Spray and Watson, 2011a) although more recent surveys (Defra, 2015) did not record these. Due to the distance between these features and the Hornsea Three offshore cable corridor, there is no potential for effects on these and mussel beds are therefore not considered further.

3.3 Screening conclusions

3.3.1.1 For Cromer Shoal Chalk Beds MCZ, the following impacts are screened into the stage 1 assessment:

- Construction:
  - Temporary habitat loss/disturbance due to cable installation; (see section 5.1.2 and Appendix A);
  - Increases in SSC and associated deposition due to cable installation; and
  - Seabed disturbance leading to sediment contamination.
- Operation:
  - Long term habitat loss due to cable protection;
  - Colonisation of cable protection; and
  - Increased risk of introduction or spread of invasive and non-native species (INNS) due to presence of subsea infrastructure and vessel movements.
- Decommissioning:
  - Temporary habitat loss/disturbance due to cable removal;
  - Increases in SSC and associated deposition due to cable removal; and
  - Permanent habitat loss due to presence of cable protection left *in situ* post decommissioning.

3.3.1.2 For Markham's Triangle rMCZ, the following impacts are screened into the stage 1 assessment:

- Construction:
  - Temporary habitat loss/disturbance due to cable laying operations, spud-can leg impacts from jack-up operations and seabed preparation works for gravity base foundations (GBFs); and
  - Increases in SSC and associated deposition from cable and foundation installation and seabed preparation.
- Operation:
  - Long term habitat loss through presence of foundations, scour protection and cable protection;
  - Colonisation of offshore foundations and scour and cable protection;
  - Increased risk of introduction or spread of INNS due to presence of subsea infrastructure and vessel movements; and
  - Alteration of seabed habitats arising from effects on physical processes, including scour effects and changes in the wave and tidal regimes.
- Decommissioning:
  - Temporary habitat loss due to operations to remove inter-array cables, substation interconnector cables and jack-up operations to remove foundations;
  - Increases in SSC and deposition from removal of inter-array cables and foundations; and
  - Permanent habitat loss due to presence of scour/cable protection left *in situ* post decommissioning.

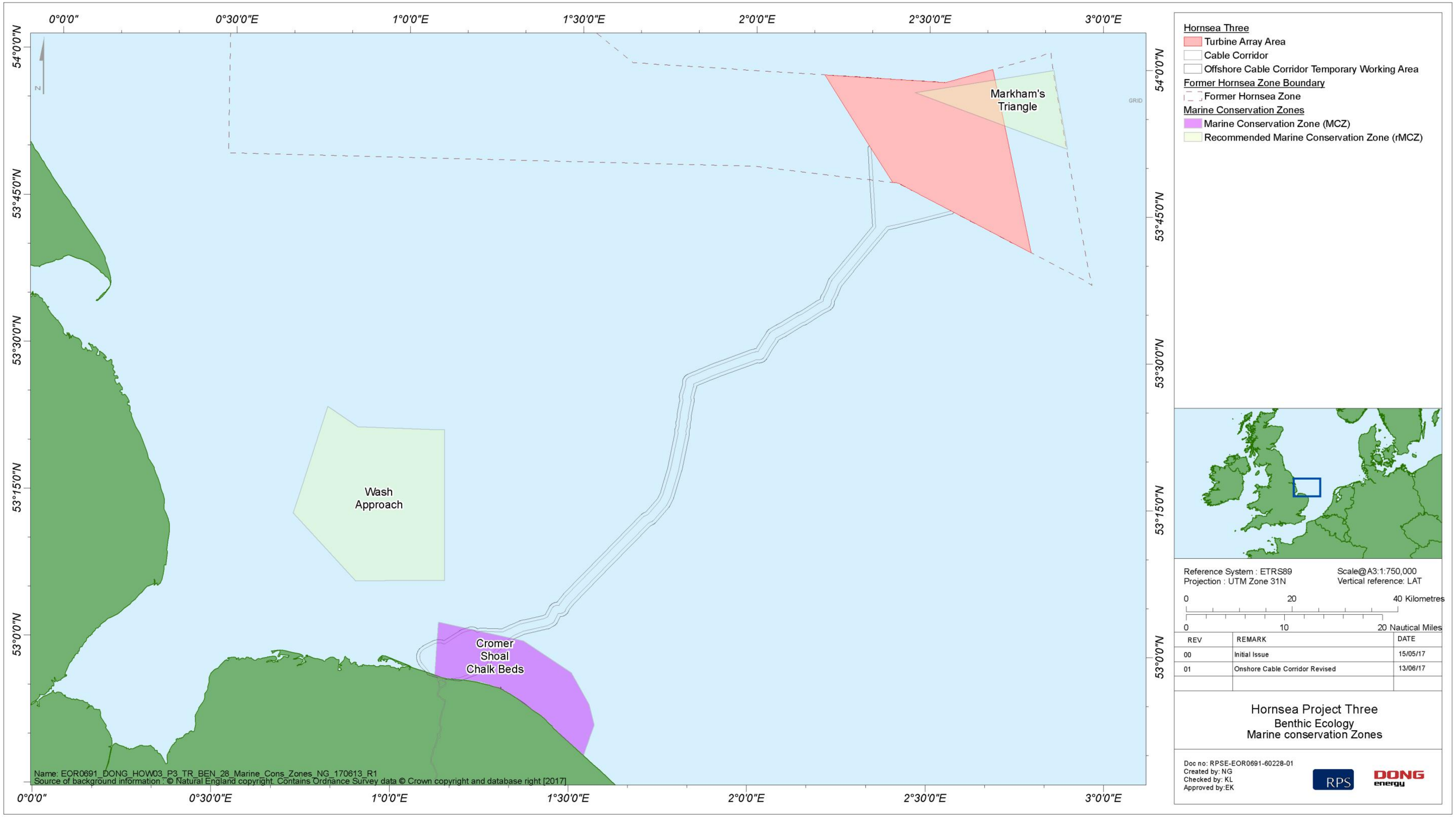

Figure 3.1: Marine Conservation Zones (MCZs) and recommended Marine Conservation Zones (MCZs) overlapping Hornsea Three or within one tidal excursion of Hornsea Three with relevant protected features.

4. Background Information on MCZs

4.1.1.1 This section provides a summary of the baseline information for each of the MCZs considered within the stage 1 assessment.

4.2 Cromer Shoal Chalk Beds MCZ

4.2.1.1 The Cromer Shoal Chalk Beds MCZ, which came into effect on 29 January 2016 (Defra, 2016a), lies from approximately 200 m from the low water mark off the north Norfolk coast and extends 10 km out to sea in waters of up to 25 m depth (Defra, 2015), covering a total area of approximately 321 km^2. The chalk and flint shores of north Norfolk represent one of the few coastal outcrops of bedrock in eastern England (Covey, 1998). The chalk shores are considered a rare habitat in northwest Europe (Covey, 1998). Off the east coast of England, notable areas of chalk shores occur at Flamborough Head in Yorkshire and on the Thanet coast in Kent, though the reef at North Norfolk is thought to be the longest, with a length of approximately 30 km (Spray and Watson, 2011a).

4.2.1.2 Volume 5, annex 2.1: Benthic Ecology Technical Report provides a detailed description of the Cromer Shoal Chalk Beds MCZ, including diver surveys undertaken within the MCZ. These diver surveys (i.e. 111 dives from 2009 to 2010, Spray and Watson (2011a); and 53 dives in 2012, Watson (2012)) focussed primarily on the more prominent features of the benthic environment, e.g. chalk reefs, and recorded a range of complex chalk habitats influenced by the high energy marine environment including gullies, overhangs, arches, ridges and flat plateaux of chalk covered with flint and chalk boulders (Spray and Watson, 2011a and 2011b). Taxa recorded included sponges, hydroids, anemones, worms and tubeworms, barnacles, crabs, shrimp, lobsters, cephalopods, sea slugs, mussels, whelks, bryozoans, starfish, urchins, brittlestars, sea squirts, seaweed and a variety of fishes (Watson, 2012). These dive surveys also recorded substantial clay ridges, inhabited by piddock bivalves Pholadidae, common lobster *Homarus gammarus* and edible crab *Cancer pagurus* (Spray and Watson, 2011a).

4.2.1.3 A dedicated vessel-based seabed survey was undertaken by Cefas between 2012 and 2014 at the Cromer Shoal Chalk Beds MCZ to provide direct evidence of the presence and extent of the broadscale habitats and habitat FOCI (Features of Conservation Importance) that had been detailed in the original Cromer Shoal Chalk Beds rMCZ Site Assessment Document (SAD; Net Gain, 2011). The geophysical survey covered 78% of the MCZ and the environmental sampling survey comprised 196 DDV locations and 70 grab sample locations with the final output producing mapping of the extents of the Habitat FOCI as shown in Figure 4.1. A total of 358 infaunal taxa and 146 epifaunal taxa were recorded during the environmental sampling campaign. An unrelated survey (George *et al.*, 1995), previously recorded 380 species of macroinvertebrates from 14 locations in the nearshore waters off the coast of north Norfolk, where infaunal and epifaunal community assemblages were found to change substantially on an annual basis (i.e. due to natural variability in the sediment type).

4.2.1.4 As shown in Figure 4.1, the nearshore section of the Hornsea Three offshore cable corridor coincides with the Cromer Shoal Chalk Beds MCZ. Geophysical survey data and seabed sampling collected for Hornsea Three in 2016 characterised the benthic sediments and communities within part of the Cromer Shoal MCZ. These habitats are shown relative to the MCZ Habitat FOCI in Figure 4.1, with a full, detailed description of these habitats and associated communities provided in volume 5, annex 2.1: Benthic Ecology Technical Report.

4.2.1.5 Table 4.1: presents the protected features of the Cromer Shoal Chalk Beds MCZ, with their spatial extents within the MCZ (where these are available) and the general management approach as stated in Defra (2016b). For the purposes of this Shadow MCZ assessment and the impact assessment presented in volume 2, chapter 2: Benthic Ecology, the Habitat C Valued Ecological Receptor (VER) shown in Figure 4.1, is analogous to the subtidal coarse sediments protected feature of the Cromer Shoal Chalk Beds MCZ and the Habitat D VER is analogous to the subtidal mixed sediment protected feature of Cromer Shoal Chalk Beds MCZ. For the Cromer MCZ, the conservation objective is to ensure the relevant protected features are maintained or brought into a "favourable condition", which, for the habitat features, is when the **extent of the habitats is stable or increasing** and relevant **structures and functions, quality and composition of characteristic biological communities are in a healthy condition and not deteriorating** (see Cromer Shoal Chalk Beds Marine Conservation Zone Designation Order; Defra, 2016a).

Table 4.1: Protected features of the Cromer Shoal Chalk Beds MCZ, recorded extents (see Figure 4.1) and general management approach.

Protected feature (Defra, 2016a)	Spatial extents within MCZ (Defra, 2015)	General Management Approach
High energy circalittoral rock	30 km^2 [a]	Maintain in favourable condition
Moderate energy circalittoral rock		Maintain in favourable condition
High energy infralittoral rock	Not confirmed present	Maintain in favourable condition
Moderate energy infralittoral rock	Not confirmed present	Maintain in favourable condition
Subtidal coarse sediments	148 km^2	Maintain in favourable condition
Subtidal mixed sediments	49 km^2	Maintain in favourable condition
Subtidal sand	18 km^2	Maintain in favourable condition
Peat and clay exposures	Several point records in the northwest of MCZ	Maintain in favourable condition
Subtidal chalk	30 km^2 [b]	Maintain in favourable condition
North Norfolk Coast assemblage of subtidal sediment features and habitats (geological feature)	Combined extents above	Maintain in favourable condition

[a]: Insufficient evidence (Defra, 2015) to refine the classification of the EUNIS biotope ‘A4 Circalittoral rock’.

[b]: While this extent is based on 78% survey coverage within the MCZ, the extent of subtidal chalk mapped by Defra (2015) is considerably less than the 189.37 km^2 predicted to be present (i.e. by modelling) in the SAD (Net Gain, 2011).

4.2.1.6 In addition to the habitat features the Cromer Shoal Chalk Beds MCZ lists the North Norfolk Coast assemblage of subtidal sediment features and habitats as a geological feature. This geological feature is comprised of the individual subtidal sediment and rock habitats features listed in Table 4.1, although the conservation objectives consider the physical aspects of this protected feature, rather than the biological species detailed in the preceding paragraph. With respect to the feature of geological interest, "favourable condition" is when its **extent, component elements and integrity** are maintained, its **structure and functioning are unimpaired** and its **surface remains sufficiently unobscured** for the purposes of determining whether the previous two conditions are satisfied.

4.3 Markham's Triangle rMCZ

4.3.1.1 Markham's Triangle rMCZ, which coincides with the northeast section of the Hornsea Three array area, is being considered for inclusion in a network of Marine Protected Areas (MPAs) in UK waters to address conservation objectives under the MCAA. Markham's Triangle is proposed for two broadscale habitats: subtidal coarse sediment and subtidal sand (see Table 4.2:). Shallow sandy sediments are considered to be a suitable habitat for sandeels (*Ammodytes* spp., a species of conservation importance) which are an important food source for a range of marine species including fish, birds and marine mammals (see volume 5 annex 3.1: Fish and Shellfish Technical Report).

4.3.1.2 Defra undertook surveys to collect evidence in support of the designation of this site in 2012. Grab samples were collected from 50 stations to characterise sediment type and infaunal communities. Video footage and still photographs were also acquired at 21 stations (Defra, 2014). The habitat 'A5.1 Subtidal coarse sediment' was dominant throughout the Markham's Triangle rMCZ, covering approximately three quarters of the site (Defra, 2014; Figure 4.2). The 'A5.2 Subtidal sand' and 'A5.4 Subtidal mixed sediments' habitats were less prevalent. Mixed sediments were mostly confined to a swathe spanning the northern boundary of the rMCZ area, while bands of sand were found across the central section of the site (Figure 4.2).

4.3.1.3 Volume 5, annex 2.1: Benthic Ecology Technical Report provides a detailed characterisation of the benthic ecology in the Hornsea Three array area, including the western portion of Markham's Triangle MCZ. This included identification of sediment types, classification of infaunal and epifaunal biotopes and ultimately identification of VERs for the purposes of the impact assessment presented in volume 2, chapter 2: Benthic Ecology.

4.3.1.4 Table 4.2: presents the habitat features of Markham's Triangle rMCZ which are proposed for designation, as recommended by Net Gain (2011), with the spatial extents of these habitats as mapped in Defra (2014). Due to this site being an rMCZ, no information on the protected features, conservation objectives, condition status or management approaches are currently available. As this information is not currently available, the general management approach for features of Markham's Triangle were assumed to be the same as those for the Cromer Shoal Chalk Beds MCZ (i.e. maintain in favourable condition), as were the conservation objectives (see paragraph 4.2.1.5). For the purposes of this Shadow MCZ assessment and the impact assessment presented in volume 2, chapter 2: Benthic Ecology, the Habitat C VER shown in Figure 4.2, is analogous to the subtidal coarse sediment habitat feature of the Markham's Triangle rMCZ, while Habitat A and Habitat B VERs are analogous to the subtidal sand habitat features of Markham's Triangle rMCZ.

Table 4.2: Protected habitats at Markham's Triangle rMCZ and recorded extents (see Figure 4.2).

Recommended feature (Net Gain, 2011)	Spatial extents within MCZ (Defra, 2014)
A5.1 Subtidal coarse sediment	145.56 km^2 [a]
A5.2 Subtidal sand	26.35 km^2 [b]

[a]: The area mapped by Defra (2014) was less than the 167.73 km^2 predicted in the SAD (Net Gain, 2011).

[b]: The area mapped by Defra (2014) was less than the 30.76 km^2 predicted in the SAD (Net Gain, 2011).

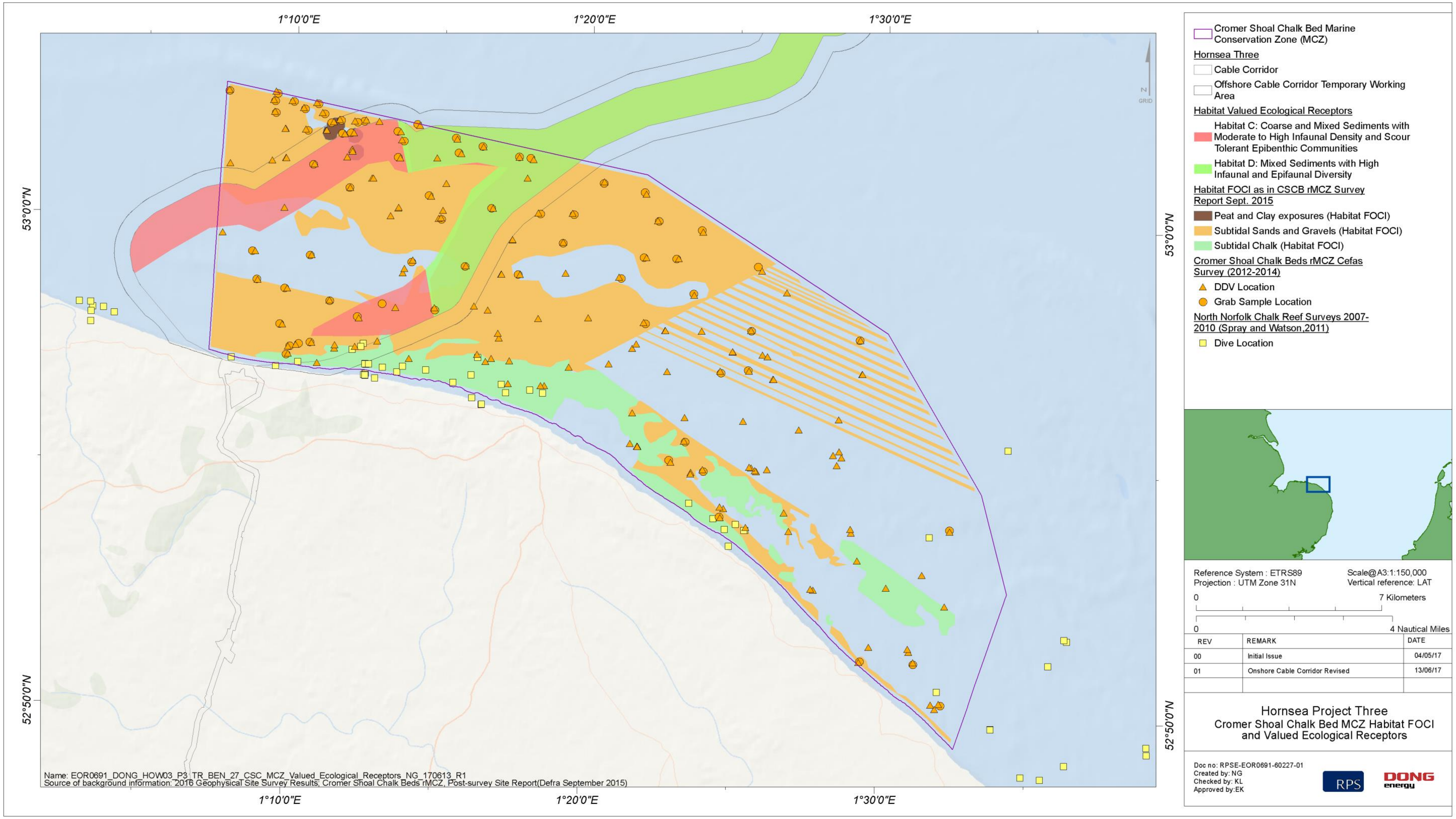

Figure 4.1: Cromer Shoal Chalk Bed MCZ habitat FOCI and VERs identified across the Hornsea Three offshore cable corridor.

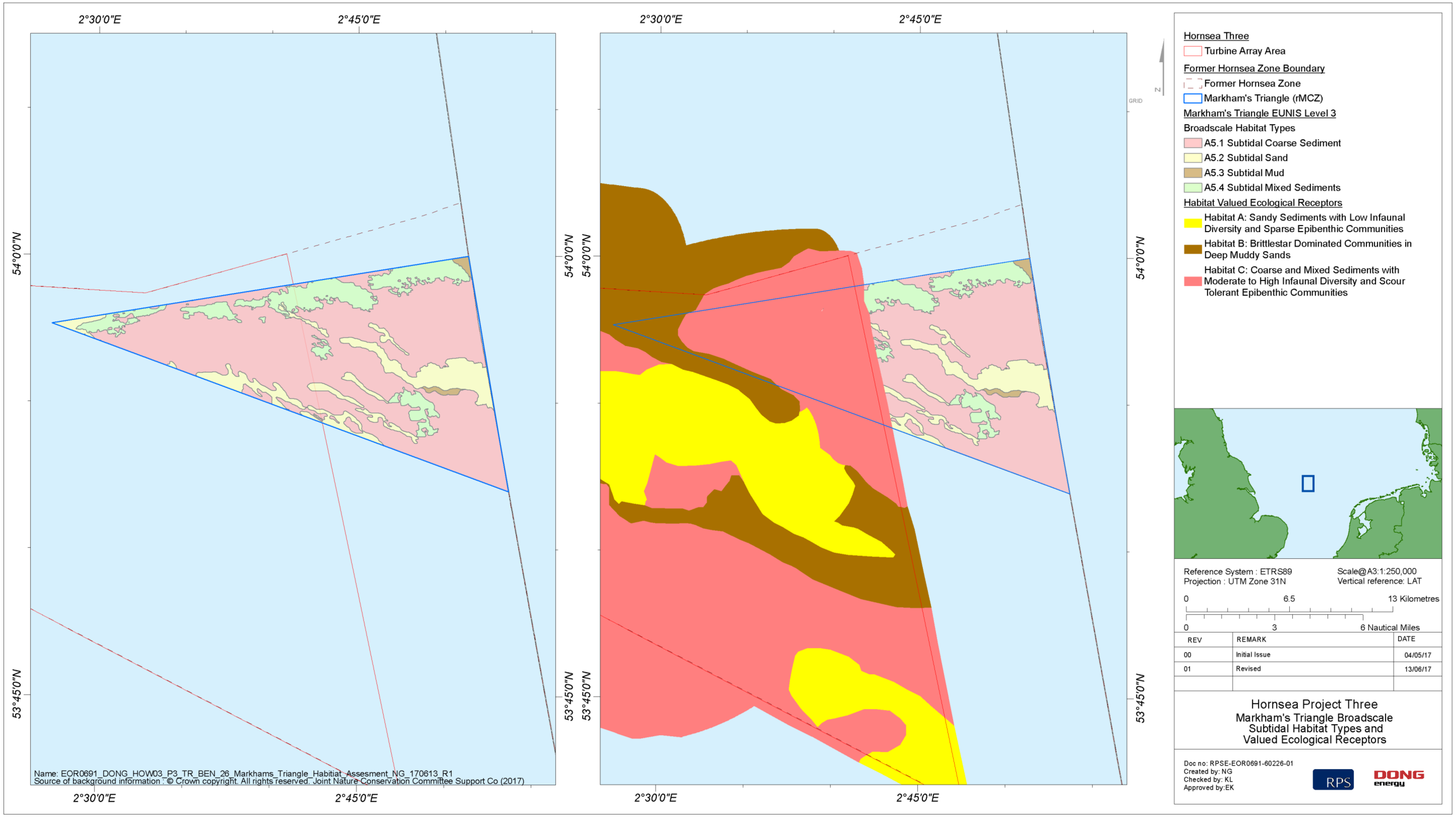

Figure 4.2: Markham's Triangle rMCZ broadscale habitat types and VERs identified within the Hornsea Three array area.

5. Stage 1 Assessment

5.1 Cromer Shoal Chalk Beds MCZ

5.1.1.1 This Shadow MCZ assessment on the protected features of the Cromer Shoal Chalk Beds MCZ should be considered preliminary for the purposes of the PEIR. There is currently limited site-specific data on the distribution and extents of habitat features, specifically subtidal chalk reef habitats and peat and clay exposures, within the section of the Hornsea Three offshore cable corridor which coincides with the MCZ. These habitat features will be mapped through benthic ecology sampling of this part of the Hornsea Three offshore cable corridor (i.e. benthic grab sampling and/or drop down video). The results of this survey will provide further baseline data to allow for a more refined assessment to be undertaken on this MCZ ahead of the DCO application. This is specifically in reference to the subtidal chalk reef habitats and peat and clay exposures and the potential for direct impacts on these (i.e. habitat loss impacts), as there is uncertainty about the exact locations of these relative to the Hornsea Three offshore cable route.

5.1.2 Construction Phase

Cable installation in the Cromer Shoal Chalk Beds MCZ leading to habitat loss/disturbance

5.1.2.1 Direct loss/disturbance of subtidal habitat within Hornsea Three at Cromer Shoal Chalk Beds MCZ will occur as a result of the burial of the export cables and the anchor placements associated with cable burial. Volume 2, chapter 2: Benthic Ecology provides further detail on the magnitude of impact and project envelope assumptions with respect to cable installation.

5.1.2.2 Of the total area of seabed predicted to be affected by cable installation (i.e. cable burial and anchor placements) within the Hornsea Three offshore cable corridor during the construction phase, a maximum of 1,026,000 m^2 will be affected within the Cromer Shoal Chalk Beds MCZ (see Table 5.1 and Table 2.20 of volume 2, chapter 2: Benthic Ecology), this area comprises 0.32% of the entire area of the MCZ. Due to uncertainties about the extents of habitat features within the MCZ at the time of writing, the maximum potential area affected (i.e. habitat loss/disturbance) due to cable burial have been estimated on the assumption that all cable installation could occur within one of the three subtidal broadscale habitat features of the MCZ, i.e. subtidal coarse sediments, subtidal mixed sediments and subtidal sand. This is considered temporary habitat loss/disturbance, with recovery of sediments and associated communities occurring following cable installation (discussed further below). The total temporary habitat loss within coarse sediments equated to 0.69% of this habitat within the MCZ, 2.09% of subtidal mixed sediments within the MCZ and 5.70% of subtidal sand within the MCZ. Based on current mapping of the Hornsea Three offshore cable corridor, the sediments were found to largely comprise of the first two sediment types; that is coarse and mixed sediments and as such, assuming that all temporary habitat loss could occur in subtidal sand is clearly likely to be highly precautionary. In any case, the percentage habitat loss/disturbance would not be the sum of these percentage areas, but either all within one habitat type (mostly likely coarse or mixed sediments) or partially across these habitat types. For the final Shadow MCZ assessment the actual temporary habitat loss/disturbance areas will be quantified according to the proportions of these habitats mapped along the Hornsea Three offshore cable corridor.

Table 5.1: Temporary habitat loss within Cromer Shoal Chalk Beds MCZ during the construction phase.

Project Element	Habitat loss/disturbance (m^2)	Assumptions (see maximum design scenario table of volume 2, chapter 2: Benthic Ecology for full description of Hornsea Three maximum design scenario)
Cable Burial	900,000	Burial of up to a total of 90 km cable length, with up to six cables, each of 15 km length within the MCZ (i.e. the maximum length between the landfall and the offshore edge of the MCZ). Cable installation will affect a corridor of up to 10 m width of seabed.
Anchor Placement	126,000	Up to seven anchors (footprint of 100 m^2 each) repositioned every 500 m of the 15 km cable length within the MCZ, with up to 6 export cables (15,000 m x 7 x 100 m^2 x 6 / 500 m = 126,000 m^2).
Total temporary habitat loss	***1,026,000***	

5.1.2.3 Following cable installation, sediments from surrounding areas will infill the cable trench, through tidal and wave action, returning quickly to a baseline state in weeks to months within areas where mobile sediments are present and over months to years within offshore areas or where surficial cover is thin or absent (volume 2, chapter 1: Marine Processes). As the sediments infill and return to a baseline state, associated faunal communities will recover into these areas (discussed further below). It should also be noted that the predicted habitat loss/disturbance is likely to be intermittent throughout the duration of the construction phase, with cables being laid within the MCZ over a maximum of three phases, with only a proportion of the total habitat loss/disturbance predicted to occur at any one time and recovery of associated communities commencing immediately after cable installation.

5.1.2.4 Cable installation may also occur in areas of subtidal chalk, with known overlap between the Hornsea Three offshore cable corridor and temporary working area and the known areas of subtidal chalk habitat (see Figure 4.1). Based on the extent of this habitat feature within the Hornsea Three offshore cable corridor, the maximum length of cable which could be buried within this habitat is 13.16 km (of the total of up to 90 km export cables within the MCZ; Table 5.1), based on the highly precautionary assumption of all six cables being laid in this part of the offshore cable corridor, with minimum spacing of 100 m between cables. This would result in loss/disturbance of up to 150,070 m^2 from cable burial and anchor placement during cable burial operations, representing 0.5% of the subtidal chalk habitat within the MCZ. Where cables are buried, it would be expected that this would result in removal of the surface substrate and subsequent infill of cable trenches by superficial sediments from the local area (e.g. sand, coarse and mixed sediments), resulting in loss of a proportion of the subtidal chalk feature, with no potential for recovery and a change of habitat type in these discrete areas. Where anchor placement occurs (i.e. up to 18,430 m^2), it is expected that the substrates would be left intact although with some damage impacts to the physical structure of the substrates. These effects may be relatively inconspicuous in areas of relatively flat substrate or more noticeable in areas where the structural complexity is greater (e.g. pinnacles, ridges, overhangs or gullies).

5.1.2.5 For peat and clay exposures, effects would be expected to be analogous to subtidal chalk, although estimates of potential areas affected are difficult to make as the extent of this habitat feature within the MCZ is not accurately mapped. This habitat feature has been recorded at discrete locations within the MCZ, primarily in the northwest of the MCZ (see Figure 4.1), some of which coincide with the offshore cable corridor and therefore have the potential to be affected by cable installation. Like subtidal chalk, where cable installation occurs within areas of peat and clay exposures, this would result in loss of this habitat feature, with no potential for recovery and a change in substrate type, with surrounding sediments likely to infill the cable trench from surrounding areas. Where anchor placement occurs, effects may be more limited, depending on the complexity of the peat and clay exposures.

5.1.2.6 For the protected sediment features, due to the temporary, reversible and intermittent nature of the impact of habitat loss/disturbance from cable installation and anchor placement, and the relatively small proportion of habitats affected during construction, it was concluded in volume 2, chapter 2: Benthic Ecology, that the magnitude of the impact on the protected sediment features of the Cromer Shoal Chalk Beds MCZ was **minor**.

5.1.2.7 Should cable installation occur within the subtidal chalk and peat and clay exposures features of the MCZ, these will result in permanent loss of these habitat features and a change in the substrate type, with no potential for recovery, although only a relatively small proportion of this habitat would be potentially affected, particularly given the precautionary assumptions made with respect to the area affected (see paragraph 5.1.2.4). The magnitude of the impact on these protected features was predicted to be **minor**. Hornsea Three is currently investigating the feasibility of avoiding these features and will seek to use this to mitigate these potential impacts, where possible, as the project evolves.

5.1.2.8 Subtidal coarse and mixed sediment biotopes identified in volume 5, annex 2.1: Benthic Ecology Technical Report included MoeVen, PoVen and other coarse and mixed sediment biotopes such as MysThyMx, all of which have typically low sensitivity to impacts resulting from physical disturbance/abrasion and displacement (Durkin, 2008; Tillin, 2016b; Tillin, 2016c; De-Bastos and Marshall, 2016). These coarse and mixed sediment communities are characterised by relatively diverse communities of polychaetes and venerid bivalves and are unlikely to experience anything other than minor localised declines in species richness. The majority of the infauna will be expected to rebury following displacement with only a small degree of mortality resulting from predation. Although some permanently attached species such as epifaunal hydroids and bryozoans will suffer mortality when removed from the substratum during construction activities, other epifaunal species which remain attached to their substrate will likely survive any physical damage and repair themselves. See volume 2, chapter 2: Benthic Ecology for further information on recoverability of communities associated with coarse and mixed sediments.

5.1.2.9 The sediments habitat features predicted to be directly affected by temporary habitat loss/disturbance typically have low sensitivity to disturbance of this nature. Subtidal sand sediment biotopes (such as NcirBat and FfabMag and IMoSa), are typical of high energy environments and are therefore naturally subject to, and tolerant of, physical disturbance. The communities that characterise these biotopes are predominantly infaunal mobile species including polychaetes and venerid bivalves, which are capable of re-entering the substratum following disturbance (Budd, 2008; Tillin, 2016a). The recoverability of such communities is likely to occur as a result of the combination of recruitment from surrounding unaffected areas and larval dispersal, and recovery is likely to occur within five years; see volume 2, chapter 2: Benthic Ecology for further information on recoverability of communities associated with subtidal sand.

5.1.2.10 Other mixed sediment biotopes known to occur along the Hornsea Three offshore cable corridor include the SspiMx and epifaunal Sspi.ByB biotopes with typically diverse epibenthic communities. This habitat is typically highly intolerant to temporary disturbance and displacement, though recoverability is also high, resulting in an overall moderate sensitivity to impacts of this nature (Marshall, 2008; Tillin and Marshall, 2015). The recoverability of associated epifauna is also expected to be high, with complete recovery likely within five years (Marshall, 2008; Tillin and Marshall, 2015); see volume 2, chapter 2: Benthic Ecology for further discussion on the recoverability of these mixed sediment communities.

5.1.2.11 As discussed in volume 2, chapter 2: Benthic Ecology, one of the key characterising species of the subtidal chalk reefs and peat and clay exposures is likely to be the piddock *Pholas dactylus* which is one of the main characterising species of the CR.MCR.SfRPid (SfRPid): 'Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay' biotope (Connor *et al*., 2004). In addition to this species' requirements for clay and soft rock to bore into, its empty burrows also provide a habitat for other species (Pinn *et al*., 2008). Following removal of the substratum, recovery of the habitat is not possible. While sub-surface layers of the same substratum type may be exposed (Tillin and Hill, 2016), these may be covered over by mobile sands or gravels making them unavailable for the associated communities such as piddocks and other sessile epifaunal species including sponges, hydroids, anemones, sea slugs, seaweed and sea squirts which were found to characterise the subtidal chalk habitats (clay exposures were found to be more sparse; see section 4.2). A change of substrate type to a sedimentary material would result in the removal of these species from the areas affected, therefore these communities are considered to have high vulnerability to this impact (Tillin and Hill, 2016). Some recovery may be expected in areas where anchor placements occur and the substrates are left intact, although this depends on the extent of the impact to the physical characteristics of the substrate (e.g. elevation from the seabed, structural complexity of the residual substrate and the extent of surrounding unaffected habitat from which recovery could occur).

5.1.2.12 Effects of habitat loss/disturbance on sediment habitat features during the construction phase will be temporary and will cease following completion of construction activities. Whilst fauna and flora will be affected, recoverability in most cases is likely to be high and typically within five years or less, as a result of passive import of larvae and active migration of juveniles and adults from adjacent non-affected areas. The subtidal coarse sediment, subtidal mixed sediment and subtidal sand features of the Cromer Shoal Chalk Beds MCZ are considered to be of low to high vulnerability, high recoverability and national importance and therefore were considered to have a **medium** sensitivity to this impact.

5.1.2.13 Sensitivities of subtidal chalk and peat and clay exposures to this impact are considerably different to those of the sediment communities, in that any physical disturbance would be on a permanent basis, i.e. damage to or removal of subtidal chalk reef or peat and clay exposures via cable burial would not be reversible. These habitat features are considered to be of high vulnerability, not recoverable and of national value. The sensitivity of the receptor is therefore, considered to be **very high**.

5.1.2.14 Volume 2, chapter 2: Benthic Ecology predicted that the magnitude of impact to be **minor** and for the protected sediment features of the Cromer Shoal MCZ (i.e. subtidal coarse sediment, subtidal mixed sediment and subtidal sand) a **medium** sensitivity was ascribed. The significance of effect was therefore considered to be **minor** adverse, which is not significant in MCAA terms.

5.1.2.15 With respect to subtidal chalk and peat and clay exposures, the magnitude of impact was predicted to be **minor** (particularly given the precautionary assumptions made with respect to the area potentially affected; see paragraph 5.1.2.4), with a **very high** sensitivity for these habitat features and therefore the significance of effect was considered to be **moderate adverse**, which is significant in MCAA terms. As noted in paragraph 5.1.2.7, Hornsea Three is currently investigating the feasibility of avoiding these features and will seek to use this to mitigate these potential impacts, where possible, as the project evolves. As outlined in section 2.10 of volume 2, chapter 2: Benthic Ecology, this will be implemented by undertaking a pre-construction survey of the final offshore cable corridor and where necessary and possible, employing appropriate mitigation to avoid direct impacts on these features.

5.1.2.16 With respect to the conservation objectives of the Cromer Shoal Chalk Beds MCZ, it can be concluded that there is no significant risk of cable installation during the construction phase, with consequent habitat loss/disturbance effects, hindering the achievement of the conservation objectives set out in Table 4.1 for the following reasons:

- While temporary habitat loss/disturbance is predicted to affect a small proportion of the designated protected habitats intermittently during the construction phase, these habitats will recover with the **extent of the designated protected features** remaining stable following the construction phase; and
- The **structures and functions, quality and composition of characteristic biological communities** will remain in a condition which is healthy and not deteriorating. Recovery of the seabed sediments will occur in the months following cable installation, with complete recovery within the areas affected within a few years, with associated communities predicted to recolonise disturbed sediments within months to years of cable installation; as supported by analogous studies from the aggregates, offshore wind and oil and gas industry.

5.1.2.17 Should cable installation occur in the subtidal chalk or peat and clay exposures habitat features, this may lead to a risk of hindering achievement of the conservation objectives set out in Table 4.1 due to a reduction in the extent of the protected features and effects on structures and functions, quality and composition of characteristic communities in areas where cable installation occurs. As such, Hornsea Three is currently investigating the feasibility of avoiding these features and will seek to use this to mitigate these potential impacts, where possible, as the project evolves, thereby minimising any risk of hindering the conservation objectives for these protected features of the Cromer Shoal Chalk Beds MCZ. This assessment will be updated as relevant prior to submission of the DCO application following receipt of further site specific information on the distribution of protected features of the MCZ within the Hornsea Three offshore cable corridor. Should any significant risk of hindering conservation objectives remain, Hornsea Three will be required to consider further mitigation and alternatives which would further minimise this risk (see paragraphs 2.3.1.6 and 2.3.1.7) and potentially undertake a Stage 2 assessment if an unacceptable residual risk remains.

5.1.2.18 With respect to the conservation objectives of the protected geological interest features of the Cromer Shoal Chalk Beds MCZ (i.e. North Norfolk Coast assemblage of subtidal sediment features and habitats), it can be concluded that there is no significant risk of cable installation during the construction phase hindering the achievement of the conservation objectives set out in Table 4.1 for the following reasons (noting the caveats with respect to subtidal chalk and peat and clay exposures outlined in paragraph 5.1.2.17 above):

- As detailed above, cable burial will lead to loss/disturbance to some of the component elements of the designated protected geological feature, although these will be limited in extent and reversible, with any disturbed sediment being reworked by wave and tidal action and returning to baseline conditions. It can therefore be concluded that the **extent, component elements and integrity** are maintained;
- Cable installation will not impair the **structure and functioning** of the protected geological feature, as discussed in paragraph 5.1.2.3, with the component elements (i.e. subtidal coarse sediment, subtidal mixed sediment and subtidal sand) returning to baseline levels soon after cable installation; and
- Burial of cables beneath surface sediments will also ensure that the protected geological feature's **surface remains sufficiently unobscured**.

5.1.2.19 This assessment will be updated as appropriate based on the findings of site-specific surveys within the MCZ (see paragraph 5.1.1.1) with the final assessment presented in the MCZ assessment to accompany the DCO application.

Increases in suspended sediment concentrations and associated deposition due to cable installation in the Cromer Shoal Chalk Beds MCZ

5.1.2.20 Increases in SSC and associated sediment deposition are predicted to occur during the construction phase as a result of cable installation. Volume 2, chapter 1: Marine Processes and volume 5, annex 1.1: Marine Processes Technical Report provide a full description of the physical assessment, including the specific assessment with respect to increases in SSC and subsequent sediment deposition, with a summary of maximum design scenarios associated with this impact presented in volume 2, chapter 1: Marine Processes.

5.1.2.21 The maximum design scenario for increases in SSC associated with export cable installation is predicted to occur as a result of installation by mass flow excavator (see chapter 1: Marine Processes and volume 2, chapter 2: Benthic Ecology for full details). Disturbance of medium to coarse sand and gravels during cable installation is likely to result in a temporally and spatially limited plume affecting SSC levels (and associated deposition) in close proximity of the point of release. SSC generated during cable burial will be locally elevated in close proximity to active burial operations (i.e. up to tens or hundreds of thousands of mg/l), although the change will only be present for a very short time locally (i.e. seconds to tens of seconds) before the material resettles to the seabed (see volume 2, chapter 1: Marine Process). Depending on the height to which the material is ejected and the current speed at the time of release, changes in SSC and deposition will be spatially limited to within metres downstream of the cable for gravels and within tens of metres for sands. Finer material will be advected away from the release location by the prevailing tidal current. High initial concentrations (similar to sands and gravels) are to be expected but will be subject to rapid dispersion, both laterally and vertically, to near-background levels (tens of mg/l) within hundreds to a few thousands of metres of the point of release. Only a small proportion of the material disturbed is expected to be fines, with a corresponding reduction in the expected levels of SSC.

5.1.2.22 Irrespective of sediment type, the volumes of sediment being displaced and deposited locally are relatively limited (up to 6 m^3 per metre of cable burial) which also limits the combinations of sediment deposition thickness and extent that might realistically occur. The assessment presented in volume 2, chapter 1: Marine Processes suggests that the extent and so the area of deposition, will normally be much smaller for sands and gravels, leading to a greater average thickness of deposition in the order of tens of centimetres to a few metres in the immediate vicinity of the cable trench. Fine material, by contrast, will be distributed much more widely, becoming so dispersed that it is unlikely to settle in measurable thickness locally (volume 2, chapter 1: Marine Processes).

5.1.2.23 The impact of increases in SSC and associated sediment deposition on protected features of the Cromer Shoal Chalk Beds MCZ is predicted to be of local spatial extent (i.e. within metres to hundreds of metres from the Hornsea Three offshore cable corridor), of short term and intermittent duration, and reversible to baseline conditions following cessation of activities. Volume 2, chapter 2: Benthic Ecology predicted that the magnitude of this impact would be **minor**.

5.1.2.24 Communities associated with subtidal coarse sediments and subtidal mixed sediments were considered to have medium resilience and high recoverability from increased SSC and sediment deposition, while those associated with subtidal sand were considered to have very low to almost no sensitivity to increased SSC and smothering; see volume 2, chapter 2: Benthic Ecology for further information on the sensitivity of these habitats to this impact.

5.1.2.25 Communities associated with subtidal chalk reefs and peat and clay exposures are likely to have some tolerance to increases in SSC (De-Bastos and Hill, 2016; Tillin and Hill, 2016), particularly as these habitats are largely located in close proximity to the coast, where SSC are highest (see chapter 1: Marine Processes). Sensitivity of many species associated with these habitat FOCI to sediment deposition would also be expected to be limited due to the resilience of some characterising species (De-Bastos and Hill, 2016) and the natural sediment mobility in these areas; see volume 2, chapter 2: Benthic Ecology for further discussion.

5.1.2.26 Communities associated with the subtidal coarse sediments, subtidal mixed sediments and subtidal sand features were considered to be of low vulnerability, medium to high recoverability and of national importance, with an overall sensitivity considered to be **low**. Communities associated with the subtidal chalk reef and peat and clay exposures habitat FOCI were considered to be of low to medium vulnerability, medium to high recoverability and of national importance with an overall sensitivity of **medium**.

5.1.2.27 Volume 2, chapter 2: Benthic Ecology predicted the magnitude of this impact to be **minor** and **low** to **medium** sensitivity for the protected features of the Cromer Shoal MCZ and therefore the significance of effect was considered to be **minor** adverse, which is not significant in MCAA terms.

5.1.2.28 With respect to the conservation objectives of the Cromer Shoal Chalk Beds MCZ, it can be concluded that there is no significant risk of increases of SSC and associated sediment deposition due to cable installation hindering the achievement of the conservation objectives set out in Table 4.1 for the following reasons:

- The **extent of the designated protected features** will not be affected by increases in SSC and associated deposition, remaining stable following the construction phase; and
- The **structures and functions, quality and composition of characteristic biological communities** will remain in a condition which is healthy and not deteriorating. Following completion of cable installation, the seabed sediments within the area affected by cable installation (and SSC and deposition) will be consistent with those present pre-construction. Many of the communities associated with the habitat features of the Cromer Shoal MCZ show some tolerance to increases in SSC and sediment deposition, particularly given sediment mobility and background SSCs in this coastal area. Given the short term, intermittent and localised nature of the impact of SSC and sediment deposition, even those species with relatively higher sensitivity would not be expected to be adversely affected.

5.1.2.29 With respect to the conservation objectives of the protected geological interest features of the Cromer Shoal Chalk Beds MCZ (i.e. North Norfolk Coast assemblage of subtidal sediment features and habitats), increases in SSC and associated sediment deposition are not predicted to affect the **extent, component elements and integrity** of the geological interest feature nor impair the **structure and functioning** of this geological interest feature. This impact will not lead to significant effects on the surface of the seabed (i.e. the majority of sediments will be deposited locally to the point of release and will be subsequently reworked by tidal and wave action) such that the **surface will remain sufficiently unobscured**.

Seabed disturbance leading to sediment contamination

5.1.2.30 Site-specific subtidal sediment contamination data is currently not available for the Hornsea Three offshore cable corridor, therefore it has not been possible to assess this impact in the PEIR. However, as discussed in volume 2, chapter 2: Benthic Ecology a site-specific survey will be undertaken along the Hornsea Three offshore cable corridor, as agreed through the Marine Processes, Benthic Ecology and Fish and Shellfish Ecology EWG, and sediment contaminant data acquired in the pending survey will inform the final Shadow MCZ assessment submitted with the DCO application.

5.1.3 Operational Phase

Placement of cable/pipeline crossings and cable protection in the Cromer Shoal Chalk Beds MCZ leading to long term habitat loss

5.1.3.1 Long term habitat loss will occur within the Cromer Shoal Chalk Bed MCZ during the operational phase where cable crossings and protection are required for sections of the export cables. Within the Cromer Shoal Chalk Beds MCZ, cable protection may be used over a maximum of 25% of the export cables installed, although this will be confirmed by engineering studies, with all other cables to be buried to an appropriate depth (subject to a cable burial risk assessment). There are predicted to be up to seven cable or pipeline crossings within the Cromer Shoal Chalk Beds MCZ.

5.1.3.2 The long term habitat loss estimates within the MCZ are based on seven cable crossings which occur within the MCZ boundary (see Table 5.2 and Table 2.20 of volume 2, chapter 2: Benthic Ecology), equating to a maximum area of seabed of 180,600 m^2 affected.

Table 5.2: Long term habitat loss within Cromer Shoal Chalk Beds MCZ during the operational phase.

Project Element	Total habitat loss (m^2)	Assumptions (see maximum design scenario table of volume 2, chapter 2: Benthic Ecology for full description of Hornsea Three maximum design scenario)
Cable protection	63,000	Cable protection required across 10% of the export cables within the MCZ. Assumes with up to six cables, each of 15 km length within the MCZ (i.e. the maximum length between the landfall and the offshore edge of the MCZ) and up to 7 m width of cable protection per cable.
Cable protection associated with cable/pipeline crossings	117,600	Up to seven crossings within the MCZ, assuming up to six cables, with each crossing having a long term loss of seabed of up to 2,800 m^2 (i.e. through placement of rock berms across a length of up to 400 m and width of 7 m).
Total long term habitat loss	***180,600***	

5.1.3.3 As detailed in volume 2, chapter 2: Benthic Ecology, cable and scour protection may comprise gravel, concrete mattresses, rock placement, bags filled with gravel, grout or other concrete, artificial fronds or seaweed or bags of grout, concrete, or another substance that cures hard over time. Hornsea Three are investigating potentially sensitive cable protection measures which could be deployed within the Cromer Shoal Chalk Beds MCZ, taking into account the local seabed conditions, including sediment type and local geology, in addition to options for decommissioning of these cable protection measures (further discussed in section 5.1.4).

5.1.3.4 Due to uncertainties about the distribution and extents of habitat features within the Hornsea Three offshore cable corridor within the Cromer Shoal Chalk Beds MCZ, the maximum potential long term habitat loss due to cable protection measures has been estimated on the assumption that all of the habitat loss could occur within one of the three subtidal broadscale habitat features of the MCZ, i.e. subtidal coarse sediments, subtidal mixed sediments and subtidal sand. The total long term habitat loss within subtidal coarse sediments equated to 0.12% of this habitat within the MCZ, 0.37% of subtidal mixed sediments within the MCZ and 1.00% of subtidal sand within the MCZ. Based on current mapping of the Hornsea Three offshore cable corridor, the sediments were found to largely comprise of the first two sediment types; that is coarse and mixed sediments and, as such, including the percentage of potential impact on subtidal sand is clearly likely to be highly precautionary. In any case, the percentage habitat loss/disturbance would not be the sum of these percentage areas, but either all within one habitat type (mostly likely coarse or mixed sediments) or partially across these habitat types. For the final Shadow MCZ assessment the actual habitat loss areas will be quantified according to the proportions of these habitats mapped along the Hornsea Three offshore cable corridor.

5.1.3.5 In addition, in many areas where cable protection is used, sediments would be expected to recover over part of the area affected, depending on the orientation of the cable protection. As discussed in volume 2, chapter 1: Marine Processes, following installation of cable protection and under favourable conditions, an initial period of sediment accumulation would be expected to occur through bed load sediment transport and saltation, creating a smooth slope against the cable protection. The process of wedge formation may take place over a period of a few months or less, depending on rates of sediment transport. It would be expected that, following accumulation of the sediments from surrounding areas on the cable protection, the biological communities associated with the surrounding sediments would also be expected to colonise these sediments. This suggests that although long term habitat loss has been assumed across all areas where cable protection is installed, this assumption is likely to overestimate the effect on biological communities, with some recovery of these communities in certain circumstances.

5.1.3.6 In areas where cable installation occurs within the subtidal chalk and peat and clay exposures protected features of the MCZ, this was predicted to result in permanent habitat loss (see paragraphs 5.1.2.4 and 5.1.2.5). If cable protection was required in these areas, this would not lead to further loss of this habitat due to the corridor width for placement of cable protection (i.e. 7 m; see Table 5.2) being smaller than the relevant width of the trench for cable burial (i.e. 10 m; see Table 5.1). Therefore no effects are predicted to occur on subtidal chalk or peat and clay exposures as a result of placement of cable protection.

5.1.3.7 Long term loss of the broadscale habitat features of the Cromer Shoal Chalk Beds MCZ is predicted to be localised in extent (i.e. within the Hornsea Three offshore cable corridor) and will be continuous and irreversible during the lifetime of the project. The impact will affect the receptors directly resulting in a relatively small change in the baseline condition and therefore it was considered that the magnitude of the impact was **minor**.

5.1.3.8 The protected features of the Cromer Shoal Chalk Beds MCZ which have the potential to be affected by long term habitat loss (i.e. subtidal coarse sediment, subtidal mixed sediment and subtidal sand) were deemed to be of high vulnerability and national importance and there is no potential for the recoverability of the affected habitats for the lifetime of the project. The sensitivity of the benthic receptors potentially affected is therefore, considered to be **high**.

5.1.3.9 Volume 2, chapter 2: Benthic Ecology predicted a **minor** magnitude impact on features of **high** sensitivity within the Cromer Shoal Chalk Beds MCZ. Due to the extensive nature of the broadscale habitat features of the MCZ, particularly the subtidal coarse and mixed sediment habitats which have the greatest potential to be affected, the significance of the effect was predicted to be **minor** adverse, which is not significant in MCAA terms.

5.1.3.10 With respect to the conservation objectives of the Cromer Shoal Chalk Beds MCZ, it can be concluded that there is no significant risk of long term habitat loss hindering the achievement of the conservation objectives set out in Table 4.1 for the following reasons:

- While Hornsea Three is predicted to result in long term loss of a small proportion of the protected features (i.e. likely to be <0.4% of the subtidal coarse sediment or subtidal mixed sediment features), these sediments are expected to be subject to some natural variability (see paragraph 4.2.1.3). In addition, as detailed in paragraph 5.1.3.2, the use of sensitive cable protection measures accounting for the local sediment types or geology may serve to limit the extent of any effects, allowing for recovery of habitats/communities in these areas. The potential for removal of these cable protection measures will also be considered as part of the decommissioning phase (see paragraph 5.1.4.6). It can therefore be concluded that the **extent of the protected features** will not be significantly affected by long term habitat loss; and
- The **structures and functions, quality and composition of characteristic biological communities** will remain in a condition which is healthy and not deteriorating. Although a small proportion of the habitat features will be lost for the lifetime of the project, the biological communities associated with the areas of unaffected coarse sediment or mixed sediment features (i.e. >99.75% of these features within the MCZ) will remain in the pre-construction baseline condition, with no effects on the structures, functions, quality and composition of the communities.

5.1.3.11 With respect to the conservation objectives of the protected geological interest feature of the Cromer Shoal Chalk Beds MCZ (i.e. North Norfolk Coast assemblage of subtidal sediment features and habitats), it can be concluded that there is no significant risk of long term habitat loss hindering the achievement of the conservation objectives set out in Table 4.1 for the following reasons:

- While it is predicted that Hornsea Three will result in long term loss of a small proportion of the qualifying features (i.e. likely to be <0.25% of the subtidal coarse sediment or subtidal mixed sediment features), these sediments are expected to be subject to some natural variability (see paragraph 4.2.1.3), with extents and distributions of these showing some natural variability within the MCZ. As discussed in paragraph 5.1.3.2, the use of sensitive cable protection measures accounting for the local sediment types or geology may serve to limit the extent of any effects, allowing for recovery of habitats/communities in these areas. The potential for removal of these cable protection measures will also be considered as part of the decommissioning phase (see paragraph 5.1.4.6). It can therefore be concluded that the overall **extent, component elements and integrity** of the protected geological interest feature of the MCZ are maintained;
- The **structure and functioning** of the protected geological interest feature of the MCZ is also predicted to be are unimpaired, with the presence of cable protection measures not predicted to have significant effects on sediment transport or the wave regime. Although initially small scale, localised sediment accumulation may occur following installation of cable protection, sediments will continue to move over cable protection measures during the operational phase, with no significant effect on the overall sediment transport in the MCZ. Any effects on the wave regime will also be highly limited in extent, with cable protection occupying a low profile within the water column relative to the depth, with minimal cross section interference to the passage of incoming waves; and
- As detailed in the previous bullet points, a limited proportion of the seabed within the MCZ will be will be affected by long term habitat loss due to cable protection at cable/pipeline crossings, resulting in some obscuring of the surface. However, this is not considered to present a significant risk to the extent, component elements and integrity or the structure and functioning of the protected geological interest feature. It can therefore be concluded that the **surface will remain sufficiently unobscured** for the purposes of determining that the conditions above are satisfied.

5.1.3.12 This assessment will be updated based on the findings of site-specific surveys within the MCZ (see paragraph 5.1.1.1) with the final assessment presented in the MCZ assessment to accompany the DCO application.

Colonisation of cable protection within the Cromer Shoal Chalk Beds MCZ

5.1.3.13 Cable protection will be required for up to 10% of the export cables installed within the MCZ and up to seven cable crossings within the MCZ. This will lead to a total of 223,347 m^2 of new hard substrate within the MCZ (see Table 5.3 and volume 2, chapter 2: Benthic Ecology). Associated increases in biodiversity will potentially affect the broadscale habitat features of the MCZ within which cable protection may be placed, i.e. subtidal coarse sediments, subtidal mixed sediments and subtidal sand. The impact on these VERs was predicted to be of local spatial extent, long term duration, continuous and irreversible during the lifetime of the project. It was predicted that the impact will affect the receptors indirectly and the magnitude was considered to be **minor**.

Table 5.3: Colonisation of cable protection within Cromer Shoal Chalk Beds MCZ during the operational phase.

Project Element	Total surface area (m^2)	Assumptions (see maximum design scenario table of volume 2, chapter 2: Benthic Ecology for full description of Hornsea Three maximum design scenario)
Cable protection	77,912	Cable protection required across 10% of the up to six export cables each of the 15 km within the MCZ (see Table 5.2). Assumes an up to 7 m wide cable corridor, cable protection to an indicative height of up to 2 m and a berm 3 m wide at the top, giving a per metre surface area of approximately 8.7 m^2
Cable protection associated with cable/pipeline crossings	145,435	Cable protection for up to seven crossings within the MCZ (see Table 5.2), assumes an up to 7 m wide cable corridor, cable protection to an indicative height of up to 2 m and a berm 3 m wide at the top, giving a per metre surface area of approximately 8.7 m^2.
Total surface area of introduced habitat	***223,347***	

5.1.3.14 Given the presence of epifaunal species and colonising fauna within discrete parts of the MCZ already (i.e. associated with coarse and mixed sediment habitats and hard substrates including chalk reefs), it is predicted that colonisation of hard substrates by common species, local to the MCZ will occur. The subtidal chalk habitat and peat and clay exposures within the Cromer Shoal Chalk Beds MCZ are not considered to be sensitive to the introduction of new hard substrate. The existing communities associated with the chalk substrate predominantly comprise an epifaunal assemblage, therefore the potential introduction of epifaunal communities associated with the new hard substrate is unlikely to incur a significant adverse impact on the function of the present community. Rather, should the introduction of new habitat be sensitive to the local sediment types or geology (as discussed in paragraph 5.1.3.2) it may allow for recovery of baseline communities into these areas.

5.1.3.15 Full discussion of sensitivities of subtidal coarse sediment, subtidal mixed sediment and subtidal sand habitats to this impact are provided in volume 2, chapter 2: Benthic Ecology, although due to the prevalence of hard substrates in the Cromer Shoal Chalk Beds MCZ, it would be assumed that sensitivity of these habitats within the MCZ would be lower than in offshore areas where hard substrates are less prevalent. These habitat features were deemed to be of low vulnerability and national importance and therefore of **low** sensitivity to this impact. Subtidal chalk reef and peat and clay exposures habitat FOCI were not considered sensitive to this impact. The significance of the effect on the Cromer Shoal Chalk Beds was therefore considered to be of **minor** adverse or beneficial significance, which is not significant in MCAA terms.

5.1.3.16 With respect to the conservation objectives of the Cromer Shoal Chalk Beds MCZ, it can be concluded that there is no significant risk of colonisation of hard substrates hindering the achievement of the conservation objectives set out in Table 4.1 for the following reasons:

- The **extent of the broadscale rock protected habitat features** (e.g. circalittoral and infralittoral rock habitats; see Table 4.1) may increase with the introduction of limited amounts of hard substrates for cable protection, with cable protection measures which are sensitive to the baseline sediment and geology area providing the greatest potential for benefit; and
- The **structures and functions, quality and composition of characteristic biological communities** will remain in a condition which is healthy and not deteriorating. As detailed above, the species assemblage most able to colonise the introduced hard substrate are likely to be already present within the MCZ (i.e. colonising coarse sediments and rocky substrates) and therefore introduction of discrete areas of hard substrate through cable protection may serve to extend the habitats within the MCZ, without adversely affecting the structure, function, quality and composition of the characterising benthic assemblage.

5.1.3.17 Colonisation of hard substrates will not affect the protected geological interest features of the Cromer Shoal Chalk Beds MCZ, with effects only predicted on the associated biological assemblage (discussed above).

Increased risk of introduction or spread of invasive and non-native species (INNS) due to presence of subsea infrastructure and vessel movements within the Cromer Shoal Chalk Beds MCZ

5.1.3.18 As discussed in paragraph 5.1.3.13 up to 223,347 m^2 of new hard substrate habitat, in the form of cable protection, will be introduced within the Cromer Shoal Chalk Beds MCZ site, which will provide new habitat for the potential colonisation by INNS. In addition, volume 2, chapter 2: Benthic Ecology considered the effect of vessel movements during the operational phase in this impact assessment, with up to 11,566 vessel movements during the construction phase and up to 2,832 round trips to port from Hornsea Three, which have the potential to contribute to the risk of introduction and spread of INNS. These vessel movements are likely to be concentrated around the Hornsea Three array area, with minimal vessel activity in the nearshore section of the Hornsea Three offshore cable corridor within the Cromer Shoal Chalk Beds MCZ. This will result in a considerably lower risk of introduction of INNS by ballast water in the MCZ. Designed-in measures including a biosecurity plan, a Project Environmental Management and Monitoring Plan (PEMMP) and vessels complying with the International Maritime Organization (IMO) ballast water management guidelines (see Table 2.18 of volume 2, chapter 2: Benthic Ecology) which will ensure that the risk of potential introduction and spread of INNS will be minimised. The magnitude of this impact was predicted to be of highly localised spatial extent, long term duration, continuous and irreversible and was therefore considered to be **negligible**.

5.1.3.19 Volume 2, chapter 2: Benthic ecology concluded that the subtidal chalk reef and peat and clay exposures habitat features were not generally considered to be sensitive to impacts by INNS (Tillin and Hill, 2016). Communities associated with these habitats are less likely be affected by the introduction of hard surfaces as these characterising epifaunal species are likely to compete with, and possibly dampen efforts by INNS to colonise the newly available habitat resource; many of the species found on chalk and clay are commonly associated with other habitats and are mobile or rapid colonisers (Tillin and Hill, 2016). While the broadscale habitat features (e.g. subtidal coarse sediment, subtidal mixed sediment and subtidal sand) may have some sensitivity to the introduction of INNS, particularly in offshore areas (see chapter 2, volume 2: Benthic Ecology), within the Cromer Shoal Chalk Beds MCZ, where extensive areas of hard substrates are present, it is assumed that the communities associated with these broadscale habitats would be less vulnerable to the introduction of INNS due to increased competition from naturally occurring epifaunal communities already present in the MCZ.

5.1.3.20 While volume 2, chapter 2: Benthic Ecology concluded that communities associated with soft sediment habitats (e.g. coarse, mixed and sandy sediments) had medium vulnerability to this impact, and were therefore of **medium** sensitivity, within the Cromer Shoal Chalk Beds MCZ it can be assumed that communities are less sensitive to this impact due to the naturally occurring hard substrates and associated faunal communities occurring within the MCZ. Sensitivity of the subtidal chalk reef and peat and clay exposures habitat FOCI was therefore predicted to be **low**. Volume 2, chapter 2: Benthic Ecology concluded an effect of **minor** adverse significance, which is not significant in MCAA terms.

5.1.3.21 With respect to the conservation objectives of the Cromer Shoal Chalk Beds MCZ, it can be concluded that the introduction or spread of INNS as a result of Hornsea Three subsea infrastructure within the Cromer Shoal Chalk Beds MCZ will not present a significant risk to hindering the achievement of the conservation objectives set out in Table 4.1 for the following reasons:

- The **extent of the protected features** will not be affected by this impact, remaining stable (or increasing); and
- The **structures and functions, quality and composition of characteristic biological communities** will remain in a condition which is healthy and not deteriorating. The risk of introduction or spread of INNS in the Cromer Shoal Chalk Beds MCZ is low and this will be minimised further through the implementation of measures such as a biosecurity plan and a PEMMP. In addition, the communities within the MCZ are not considered to be vulnerable to the introduction of INNS, with competition from local epifaunal communities likely to dampen any effects of INNS, in the unlikely event that non-native species were introduced. The use of sensitive cable protection measures accounting for the baseline sediments and geology (see paragraph 5.1.3.2) would also limit the risk of INNS colonisation, while also maximising potential benefits to local epifaunal communities (see paragraph 5.1.3.14).

5.1.3.22 Risk of introduction and spread of INNS will not affect the protected geological interest features of the Cromer Shoal Chalk Beds MCZ, with effects only predicted on the associated biological assemblage (discussed above).

5.1.4 Decommissioning Phase

Cable removal in the Cromer Shoal Chalk Beds MCZ leading to habitat loss/disturbance

5.1.4.1 Effects of temporary habitat loss during the decommissioning phase within the Cromer Shoal Chalk Beds MCZ are expected to be equal to or less than those of the construction phase (see paragraph 5.1.2.1). Cable removal will lead to temporary habitat loss/disturbance to those same habitats affected by cable burial during the construction phase. As detailed in paragraph 5.1.2.1 *et seq*., this will affect a small proportion of the protected features of the MCZ and the sediments and associated communities would be expected to fully recover following cable removal.

5.1.4.2 The key difference for cable removal activities during the decommissioning phase relates to effects on the subtidal chalk and peat and clay exposures, listed as protected features of the Cromer Shoal Chalk Beds MCZ. As detailed in paragraph 5.1.2.4, cable installation during construction in these areas would result in habitat loss which is permanent and irreversible and therefore decommissioning of cables would not lead to further loss of these habitats. Anchor placement within these areas during decommissioning would lead to habitat loss/disturbance, although as detailed in paragraph 5.1.2.4, the extent of disturbance and therefore the potential for recovery of communities would be dependent on the structural complexity of these features, e.g. presence of gullies, pinnacles etc. Anchor placement during decommissioning is predicted to affect up to 18,470 m^2 during the decommissioning phase, or approximately 0.06% of the subtidal chalk feature within the Cromer Shoal Chalk Beds MCZ. The proportion of the peat and clay exposures features of the MCZ which may be affected by anchor placements during decommissioning is more difficult to quantify due to the patchy distribution within the Cromer Shoal Chalk Beds MCZ. The magnitude of impact on these habitats is therefore predicted to be **minor**.

5.1.4.3 Sensitivity of subtidal chalk and peat and clay exposures features of the MCZ are discussed in paragraph 5.1.2.11, although sensitivity of these features is expected to be lower, as anchor placement will leave the substrate intact, allowing for recovery of communities associated with these protected habitat features. Sensitivity of subtidal chalk and peat and clay exposures is therefore considered to be **high**. Given the minor magnitude of impact and the high sensitivity of subtidal chalk and peat and clay exposures to anchor placement during decommissioning, the significance of effect was considered to be minor adverse, which is not considered significant in MCAA terms (particularly given the precautionary assumptions made with respect to the proportion of subtidal chalk potentially affected; see paragraph 5.1.2.4). As noted in section 5.1.2, Hornsea Three is currently investigating the feasibility of avoiding these features and will seek to use this to mitigate these potential impacts, where possible, as the project evolves.

5.1.4.4 As discussed in paragraph 5.1.2.16, with respect to the conservation objectives of the Cromer Shoal Chalk Beds MCZ, and due to the reduced level of impact on features of the Cromer Shoal Chalk Beds MCZ from those of the construction phase, it can be concluded that there is no significant risk of cable removal during decommissioning leading to habitat loss/disturbance hindering the achievement of the conservation objectives set out in Table 4.1.

Increases in SSC and associated deposition due to cable removal in the Cromer Shoal Chalk Beds MCZ

5.1.4.5 Effects of increases in SSC and associated deposition due to cable removal in the Cromer Shoal Chalk Beds MCZ are expected to be equal or less than those of the construction phase (see paragraph 5.1.2.20). Cable removal will lead to increases in SSCs and subsequent deposition to levels similar, or identical to, those experienced during the construction phase (i.e. due to the similarity in some of the methods used to install and remove cables, e.g. jetting). The communities predicted to be affected will be identical to those during the construction phase (allowing for some natural variation in the communities), and as discussed in paragraph 5.1.2.20 *et seq*., these are predicted to have low sensitivity to increases in SSC and sediment deposition. As discussed in paragraph 5.1.2.28, with respect to the conservation objectives of the Cromer Shoal Chalk Beds MCZ, it can be concluded that cable removal leading to increases in SSC and associated deposition will not result in a significant risk of hindering the achievement of the conservation objectives set out in Table 4.1.

Permanent habitat loss due to presence of cable protection left in situ post decommissioning within the Cromer Shoal Chalk Beds MCZ

5.1.4.6 The assessment of impacts during the Hornsea Three decommissioning phase, as presented in volume 2, chapter 2: Benthic Ecology assumes that all offshore infrastructure will be removed from the seabed with the exception of cable (and scour) protection which, it is currently assumed, will be left *in situ*. Hornsea Three will continue to discuss the need for, and feasibility of, removal of cable and scour protection in sensitive areas as the project progresses. Assessments will be updated accordingly to take account of any such discussions ahead of the final application.

5.1.4.7 As detailed in paragraph 5.1.3.7, cable protection may be installed at up to seven cable/pipeline crossings which occur within the MCZ boundary, equating to a maximum area of seabed of 180,600 m^2 affected (see Table 5.1). As a proportion of the habitat features of the MCZ, this equated to 0.12% of subtidal coarse sediments, 0.37% of subtidal mixed sediments and 1.00% of subtidal sand within the MCZ. Based on current mapping of the Hornsea Three offshore cable corridor, the sediments were found to largely comprise of the first two sediment types; that is coarse and mixed sediments and, as such, including the percentage of potential impact on subtidal sand is likely to be highly precautionary. In any case, the percentage habitat loss/disturbance would not be the sum of these percentage areas, but either all within one habitat type (mostly likely coarse or mixed sediments) or partially across these habitat types. For the final Shadow MCZ assessment the actual habitat loss areas will be quantified according to the proportions of these habitats mapped along the Hornsea Three offshore cable corridor.

5.1.4.8 In addition, as discussed in paragraph 5.1.3.3, in many areas where cable protection is used, sediments would be expected to recovery over part of the area affected, depending on the orientation of the cable protection. Where this sediment accumulation occurs, it would be expected that the biological communities associated with the surrounding sediments would also be expected to colonise these sediments. This suggests that although habitat loss has been assumed across all areas where cable protection is installed, this assumption is likely to overestimate the effect on biological communities, with some recovery of these communities in certain circumstances.

5.1.4.9 As discussed in paragraph 5.1.3.2, in addition to considering the potential for decommissioning of cable protection within the MCZ, Hornsea Three area also considering the use of sensitive cable protection measures which account for the local sediment types or geology, as these have the potential to limit the extent of any effects, allowing for recovery of habitats/communities in these areas both during the operational phase and following decommissioning. As the Project Description is further refined, the assessments presented within the PEIR shall be updated in the Environmental Statement to accompany the DCO.

5.1.5 Stage 1 Assessment Conclusion

5.1.5.1 Subject to the assessments on the protected subtidal chalk and peat and clay exposures features of the Cromer Shoal Chalk Beds MCZ (see paragraph 5.1.2.17), based on the information presented in the preceding sections, it can be concluded that there is no significant risk of Hornsea Three construction, operation and decommissioning hindering the achievement of the conservation objectives for the Cromer Shoal Chalk Beds MCZ, as set out in Table 4.1 and section 4.2 (in accordance with s.125(2)(a) of the MCAA.

5.2 Markham's Triangle rMCZ

5.2.1 Construction Phase

Temporary habitat loss/disturbance due to cable installation in the Markham's Triangle rMCZ

5.2.1.1 Direct temporary loss/disturbance of protected features of the Markham's Triangle rMCZ will occur as a result of the jack-up barge operations to install foundations, seabed preparation prior to gravity base installation and the burial of array and substation interconnector cables. Volume 2, chapter 2: Benthic Ecology provides further detail on the magnitude of impact and project envelope assumptions with respect to temporary habitat loss for Hornsea Three.

5.2.1.2 For the purposes of this Shadow MCZ assessment, it is assumed that a maximum of 22% of the array infrastructure could be placed in the part of the Hornsea Three array area which coincides with the rMCZ. This assumption is based on the maximum number of structures that could be placed within this part of the Hornsea Three array area, assuming a minimum spacing of 1 km between foundations (i.e. 76 foundations for turbines, substations and accommodation platforms, of a total 342 offshore structures). This would result in a maximum of 3,624,936 m^2 of habitat loss/disturbance within the Markham's Triangle rMCZ (see Table 5.4), equating to 1.8% of the entire area of the rMCZ. Assuming this habitat loss/disturbance would occur entirely within the subtidal coarse sediment broadscale habitat features of the rMCZ, this would equate to habitat loss/disturbance of up to 2.49% of this habitat feature within the rMCZ. The same assumption within the subtidal sand broadscale habitat feature of the rMCZ would result in up to 11.78% of this habitat feature being affected, although due to the limited extent of subtidal sand within this part of the Hornsea Three array area (i.e. this habitat covers approximately 10% of the area of the rMCZ coinciding with the Hornsea Three array area; see Figure 4.2), this is considered to be an unrealistic scenario. Since the subtidal sand habitat feature extends over approximately 10% of the area of the rMCZ coinciding with the Hornsea Three array area (see Figure 4.2), for the purposes of this assessment, it is assumed that 10% of the maximum habitat loss from Hornsea Three within the rMCZ could occur in this habitat, equating to 362,494 m^2, or 1.18% of this habitat within the rMCZ.

5.2.1.3 As detailed in volume 2, chapter 2: Benthic Ecology, activities resulting in temporary habitat loss/disturbance will occur intermittently throughout the construction period, with only a proportion of the total maximum area of habitat loss/disturbance occurring at any one time. Following these activities, sediments would be expected to quickly recover to their baseline states through tidal and wave action, allowing for associated faunal communities to recover into these areas (discussed further below).

5.2.1.4 Due to the temporary, reversible and intermittent nature of the impact of temporary habitat loss/disturbance, and the relatively small proportion of habitat features predicted to be affected during construction, it was concluded in volume 2, chapter 2: Benthic Ecology, that the magnitude of the impact on the features of the Markham's Triangle rMCZ was **minor**.

5.2.1.5 Sensitivity of the subtidal coarse sediment and subtidal sand are briefly discussed in paragraph 5.1.2.8 and discussed in detail in volume 2, chapter 2: Benthic Ecology. Effects of habitat loss/disturbance during the construction phase will be temporary and will cease following completion of construction activities. Whilst fauna and flora will be affected, recoverability in most cases is likely to be high and typically within five years or less, as a result of passive import of larvae and active migration of juveniles and adults from adjacent non-affected areas. The subtidal coarse sediment and subtidal sand features of the Markham's Triangle rMCZ are considered to be of low to medium vulnerability, high recoverability and national importance and therefore were considered to have a **low** sensitivity to this impact.

Table 5.4: Temporary habitat loss within Markham's Triangle rMCZ during the construction phase.

Project Element	Total habitat loss (m^2)	Assumptions (see maximum design scenario table of volume 2, chapter 2: Benthic Ecology for full description of Hornsea Three maximum design scenario)
Jack up footprints	163,653	Assumes maximum of 22% of total habitat loss from jack up placements within the Hornsea Three array area (see volume 2, chapter 2: Benthic Ecology).
Seabed preparation for gravity base foundations	966,910	Assumes maximum of 22% of total habitat loss from seabed preparation for gravity base foundations within the Hornsea Three array area (see volume 2, chapter 2: Benthic Ecology).
Array and substation interconnector cables	2,388,889	Assumes maximum of 22% of total habitat loss from 850 km of array cables and 225 km of substation interconnector cables within the array, affecting a corridor up to 10 m width (see volume 2, chapter 2: Benthic Ecology).
Sandwave clearance	22,397	Habitat loss from dredging of sandwaves within Markham's Triangle, assuming a volume of up to 17,655 m^3 removed from a 30 m wide corridor.
Sandwave clearance disposal activities	35,310	Habitat loss from placement of coarse dredged material to a uniform thickness of 0.5 m as a result of sandwave clearance within Markham's Triangle, assuming a volume of up to 17,655 m^3, placed on the seabed within Markham's Triangle.
Anchor placements during cable installation	47,778	Assumes maximum of 22% of total habitat loss from cable installation vessel anchor placements across the Hornsea Three array (see volume 2, chapter 2: Benthic Ecology).
Total temporary habitat loss	***3,624,936***	

5.2.1.6 Volume 2, chapter 2: Benthic Ecology predicted that the magnitude of impact to be **minor** and **low** sensitivity for the features of the Markham's Triangle rMCZ and therefore the significance of effect was considered to be **minor** adverse, which is not significant in MCAA terms.

5.2.1.7 Conservation objectives are not currently available for the Markham's Triangle rMCZ and therefore for the purposes of this Shadow MCZ assessment, it has been assumed that a general management approach of "maintain in favourable condition" will be implemented for features of the Markham's Triangle rMCZ. Based on the information presented here, it can be concluded that temporary habitat loss/disturbance during the Hornsea Three construction phase will not lead to a significant risk of hindering the achievement of the assumed conservation objectives for the features of the Markham's Triangle rMCZ for the following reasons:

- While temporary habitat loss/disturbance is predicted to affect a small proportion of the habitat features intermittently during the construction phase, these habitats will recover with the **extent of the designated features** remaining stable following the construction phase; and

- The **structures and functions, quality and composition of characteristic biological communities** will remain in a condition which is healthy and not deteriorating. Recovery of the seabed sediments will occur in the months following cable installation, with complete recovery within the areas affected within a few years and associated communities predicted to recolonise disturbed sediments, with full recovery of characteristic biological communities within months to years of construction; as supported by analogous studies from the aggregates, offshore wind and oil and gas industry.

Increases in SSC and associated deposition due to construction operations within the Markham's Triangle rMCZ

5.2.1.8 Increases in SSC and associated sediment deposition are predicted to occur during the construction phase as a result of cable installation. Volume 2, chapter 1: Marine Processes and volume 5, annex 1.1: Marine Processes Technical Report provide a full description of the physical assessment, including the specific assessment with respect to increases in SSC and subsequent sediment deposition, with a summary of maximum design scenarios associated with this impact presented in the maximum design scenario table of volume 2, chapter 1: Marine Processes. Volume 2, chapter 2: Benthic Ecology provides a summary of the magnitude of this impact, including the expected levels of SSC and associated deposition within the Hornsea Three array area, including Markham's Triangle rMCZ.

5.2.1.9 The impact of increases in SSC and associated sediment deposition on features of the Markham's Triangle rMCZ was predicted to be of regional spatial extent (i.e. increased SSCs to a few kilometres from the Hornsea Three array area, with deposition occurring much more locally), of short term and intermittent duration, and reversible to baseline conditions following cessation of construction activities. Volume 2, chapter 2: Benthic Ecology predicted that the magnitude of this impact would be **minor**.

5.2.1.10 As discussed in paragraph 5.1.2.24 (and discussed in detail volume 2, chapter 2: Benthic Ecology) communities associated with the subtidal coarse sediment and subtidal sand broadscale habitat features were considered to be of low vulnerability, medium to high recoverability and of national importance, with overall sensitivity considered to be **low**.

5.2.1.11 Volume 2, chapter 2: Benthic Ecology predicted the magnitude of this impact to be **minor** and **low** sensitivity for the features of the Markham's Triangle rMCZ and therefore the significance of effect was considered to be **minor** adverse, which is not significant in MCAA terms.

5.2.1.12 Based on the information presented here, it can be concluded that increase in SSC and associated deposition during the construction phase will not lead to a significant risk of hindering the achievement of the assumed conservation objectives for the features of the Markham's Triangle rMCZ (i.e. a general management approach of "maintain in favourable condition") for the following reasons:

- The **extent of the designated features** will not be affected by increases in SSC and associated deposition, remaining stable following the construction phase; and
- The **structures and functions, quality and composition of characteristic biological communities** will remain in a condition which is healthy and not deteriorating. Following completion of construction operations, the seabed sediments within the areas affected by SSC and deposition will be consistent with those present pre-construction. Many of the communities associated with the habitat features of Markham's Triangle rMCZ show tolerance or low sensitivity to increases in SSC and sediment deposition, primarily due to the dominance of infaunal communities.

5.2.2 Operational Phase

Long term habitat loss through presence of foundations, scour protection and cable protection in the Markham's Triangle rMCZ

5.2.2.1 Long term habitat loss will occur within the Markham's Triangle rMCZ directly under all foundation structures and associated scour protection, and array and substation interconnector cables where cable protection is required. Full details of the infrastructure to be installed within the Hornsea Three array area (including Markham's Triangle rMCZ) are presented in the maximum design scenario table of volume 2, chapter 2: Benthic Ecology. This long term habitat loss will directly affect the subtidal coarse sediment and subtidal sand habitat features of the rMCZ.

5.2.2.2 As detailed in paragraph 5.2.1.2, for the purposes of this Shadow MCZ assessment, it is assumed that a maximum of 22% of the array infrastructure could be placed in the part of the Hornsea Three array area which coincides with the rMCZ. This assumption is based on the maximum number of structures that could be placed within this part of the Hornsea Three array area, assuming a minimum spacing of 1 km between foundations (i.e. 76 foundations for turbines, substations and accommodation platforms, of a total 342 offshore structures see paragraph 5.2.1.2). Based on this, long term habitat loss is predicted to affect up to 640,269 m^2 of seabed within the Markham's Triangle rMCZ (see Table 5.5). On the assumption that this habitat loss occurs entirely within the subtidal coarse sediment feature, this would equate to 0.44% of this habitat feature of the rMCZ. The same assumptions within the subtidal sand habitat feature would affect up to 2.08% of this habitat within the rMCZ, although due to the limited extent of subtidal sand within this part of the Hornsea Three array area this is expected to the highly precautionary with most of this habitat loss expected to occur in the subtidal coarse sediment habitat. The subtidal sand habitat feature extends over approximately 10% of the area of the rMCZ coinciding with the Hornsea Three array area (see Figure 4.2) and therefore for the purposes of this assessment, it is assumed that 10% of the maximum habitat loss from Hornsea Three within the rMCZ could occur in this habitat, equating to 64,027 m^2, or 0.21% of this habitat within the rMCZ.

Table 5.5: Long term habitat loss within Markham's Triangle rMCZ during the operational phase.

Project Element	Total habitat loss (m^2)	Assumptions (see maximum design scenario table of volume 2, chapter 2: Benthic Ecology for full description of Hornsea Three maximum design scenario)
Foundations and scour protection	470,247	Assumes maximum of 22% of total long term habitat loss from gravity base foundations and associated scour protection within the Hornsea Three array area (see volume 2, chapter 2: Benthic Ecology).
Cable protection associated with inter array and substation interconnector cables	167,222	Assumes maximum of 22% of total habitat loss from cable protection associated with 850 km of inter array cables and 225 km of substation interconnector cables within the Hornsea Three array area (10% of all cables requiring cable protection, affecting a corridor up to 7 m width (see volume 2, chapter 2: Benthic Ecology).
Cable protection associated with cable/pipeline crossings	2,800	Up to one crossings within the rMCZ, with long term loss of seabed of up to 2,800 m^2 (i.e. through placement of rock berms across a length of up to 400 m and width of 7 m).
Total long term habitat loss	***640,269***	

5.2.2.3 As detailed in volume 2, chapter 2: Benthic Ecology, cable and scour protection may comprise gravel, concrete mattresses, rock placement, bags filled with gravel, grout or other concrete, artificial fronds or seaweed or bags of grout, concrete, or another substance that cures hard over time. Hornsea Three are investigating potentially sensitive cable and scour protection measures which could be deployed within Markham's Triangle rMCZ, taking into account the local seabed conditions, including sediment types, in addition to options for decommissioning of these cable protection measures (further discussed in section 5.2.3). The use of sensitive measures which account for the baseline conditions and sediments (e.g. gravel or cobbles) or encourage burial of the scour/cable protection by the surrounding sediment, may serve to reduce any potential effect of long term habitat loss. Where such measures can be employed, biological communities associated with the habitat features of the rMCZ will colonise these areas, reducing the extent of long term habitat loss. Where hard substrates are used, these are likely to become colonised by local epifaunal communities (discussed further in paragraph 5.2.2.6 *et seq*.), providing some limited recovery of communities in areas where scour and cable protection is placed.

5.2.2.4 Long term loss of the subtidal coarse sediment and subtidal sand habitat features of the Markham's Triangle rMCZ is predicted to be localised within the western area of the rMCZ, affecting only a small proportion of the habitat features. This impact will be continuous and irreversible during the lifetime of the project, and will affect the receptors directly resulting in a relatively small change in the baseline condition and therefore the magnitude was considered to be **minor**. The habitat features of the rMCZ are deemed to be of **high** sensitivity due to their high vulnerability with no potential for the recoverability for the lifetime of the project. As such, the effect on the features of the Markham's Triangle rMCZ was predicted to be of **minor** adverse significance, which is not significant in MCAA terms.

5.2.2.5 Based on the information presented here, it can be concluded that long term habitat loss/disturbance associated with Hornsea Three will not lead to a significant risk of hindering the achievement of the assumed conservation objectives for the features of the Markham's Triangle rMCZ (i.e. a general management approach of "maintain in favourable condition") for the following reasons:

- Hornsea Three is predicted to result in long term loss of a small proportion of the qualifying features (i.e. <0.5% of the subtidal coarse sediment or subtidal sand features), although as noted in section 4.3, these habitats are extensive across the rMCZ. As noted in paragraph 5.2.2.3, use of sensitive cable and scour protection measures may also allow for some recovery of sediments and communities into these areas, further reducing the proportion of habitat affected. The potential for removal of these hard substrates will also be considered as part of the decommissioning phase (see paragraph 5.2.3.4). It can therefore be concluded that the **extent of the designated features** will not be significantly affected by long term habitat loss;
- The **structures and functions, quality and composition of characteristic biological communities** across the rMCZ will remain in a condition which is healthy and not deteriorating. Although a small proportion of the habitat features will be lost for the lifetime of the project, the biological communities across the unaffected >99.5% of the habitat features of the rMCZ will remain in the pre-construction baseline condition with no effects on the structures, functions, quality and composition of the communities. In addition, as discussed in paragraph 5.2.2.3, some recovery of elements of the characteristic biological communities to areas affected by long term habitat loss would be expected.

Colonisation of offshore foundations and scour and cable protection within Markham's Triangle rMCZ

5.2.2.6 Introduction of hard substrates as a result of installation of foundation structures and associated scour protection, and cable protection for array and substation interconnector cables will occur within the Markham's Triangle rMCZ leading to colonisation of these hard substrates. Based on the assumptions set out in the maximum design scenario table of volume 2, chapter 2: Benthic Ecology, a total of 887,583 m^2 of hard substrate will be introduced into the Markham's Triangle rMCZ for the duration of the Hornsea Three operational phase (i.e. as per paragraph 5.2.1.2, assuming a maximum of 22% of the array infrastructure in the rMCZ; see Table 5.6). This impact will indirectly affect the subtidal coarse sediment and subtidal sand habitat features of the rMCZ. The magnitude of the impact was predicted to be **minor** due to the localised spatial extent of this long term duration, continuous and irreversible (during the lifetime of the project) impact.

Table 5.6: Maximum surface area from introduction of hard substrate within Markham's Triangle rMCZ during the operational phase.

Project Element	Total surface area (m^2)	Assumptions (see maximum design scenario table of volume 2, chapter 2: Benthic Ecology for full description of Hornsea Three maximum design scenario)
Foundations and scour protection	470,247	Assumes maximum of 22% of total habitat created from gravity base foundations and associated scour protection within the Hornsea Three array area (see volume 2, chapter 2: Benthic Ecology).
Cable protection associated with inter array and substation interconnector cables	167,222	Assumes maximum of 22% of total habitat created from cable protection associated with 850 km of inter array cables and 225 km of substation interconnector cables within the Hornsea Three array area (see volume 2, chapter 2: Benthic Ecology).
Cable protection associated with cable/pipeline crossings	3,463	Up to one crossings within the rMCZ, with habitat creation along a cable length of up to 400 m (see volume 2, chapter 2: Benthic Ecology).
Total long term habitat loss	***887,583***	

5.2.2.7 Within Markham's Triangle rMCZ, hard substrates are relatively rare with a seabed characterised by sand and coarse sediments (see Figure 4.2) and therefore introduction of hard substrates to these soft sediment habitats will represent a change in the communities within the rMCZ, enabling establishment of species not usually associated with soft sediment habitats. Volume 2, chapter 2: Benthic Ecology discusses the sensitivities of the habitats within Hornsea Three, including the subtidal coarse sediment and subtidal sand habitat features of the rMCZ, to this impact using evidence gathered from studies examining colonisation of offshore foundations (e.g. Krone *et al*., 2013; Lindeboom *et al*., 2011). These studies showed that reef effects are largely limited to the offshore structures themselves with some effects (e.g. accumulation of mussel shell debris) in proximity to these structures. It was concluded that given the presence of epifaunal species in parts of the Hornsea Three array area (i.e. associated with coarse sediment habitats, including gravel, cobbles and boulders), colonisation of hard substrates would most likely be by common species, such as bryozoans, hydroids and ascidians, which are known to occur in the Hornsea Three array area and Markham's Triangle rMCZ. Sensitivity of the subtidal coarse sediment and subtidal sand habitat features of the rMCZ was considered to be **low** and combined with the **minor** magnitude of impact, it was predicted that the effect would be of **minor** adverse or beneficial significance which was not significant in MCAA terms.

5.2.2.8 Based on the information presented here, it can be concluded that colonisation of hard substrates associated with Hornsea Three will not lead to a significant risk of hindering the achievement of the assumed conservation objectives for the features of the Markham's Triangle rMCZ (i.e. a general management approach of "maintain in favourable condition") for the following reasons:

- The **extents of the designated features** will not be affected by this impact;
- The **structures and functions, quality and composition of characteristic biological communities** across the rMCZ will remain in a condition which is healthy and not deteriorating. The introduction of hard substrates will offer opportunities for epifaunal communities already present within Markham's Triangle rMCZ (e.g. colonising coarse gravelly sediments, cobbles and boulders) to expand their range onto the introduced hard substrates. Some reef effects may result in expansion of taxa normally associated with hard substrates colonising areas of subtidal coarse sediment or subtidal sand, although these effects are likely to be limited to the immediate vicinity of offshore structures. In addition, the taxa with the greatest potential for such opportunities are native to the southern North Sea (e.g. mussels and barnacles) as was evidenced from previous colonisation studies in the North Sea (e.g. Krone *et al*., 2013; Lindeboom *et al*., 2011.

Increased risk of introduction or spread of INNS due to presence of subsea infrastructure and vessel movements (e.g. ballast water) within Markham's Triangle rMCZ

5.2.2.9 As discussed in paragraph 5.2.2.6, up to 894,893 m^2 of hard substrate will be introduced to the Markham's Triangle rMCZ for the duration of the Hornsea Three operational phase, presenting opportunities for colonisation by INNS. There will also be a risk of introduction and spread of INNS in ballast water through the up to 11,566 vessel movements during the construction phase and up to 2,832 annual round trips to port during the operational phase of Hornsea Three. While the risk is greatest within the Hornsea Three array area, where the majority of introduced habitat will be placed and the majority of vessel movements will be focussed, the implementation of appropriate control measures will minimise this risk as much as practical. These include a biosecurity plan, a PEMMP and vessels complying with the IMO ballast water management guidelines (see Table 2.18 of volume 2, chapter 2: Benthic Ecology). The magnitude of this impact was therefore predicted to be **negligible;** once these measures were taken into account.

5.2.2.10 Volume 2, chapter 2: Benthic Ecology discusses the sensitivity of benthic communities, including those associated with the subtidal coarse sediment and subtidal sand habitat features of Markham's Triangle rMCZ to the introduction and spread of INNS, identifying some of the key species of concern, including Japanese skeleton shrimp *Caprella mutica*, the carpet sea squirt *Didemnum vexillum* and the American slipper limpet *Crepidula fornicata*. Sensitivity of the subtidal coarse sediment and subtidal sand habitat features of the rMCZ was considered to be **medium**, although given the designed-in measures to be implemented during the operational phase of Hornsea Three, the significance of the effect was predicted to be **minor**, which is not significant in MCAA terms.

5.2.2.11 Based on the information presented here, it can be concluded that the potential introduction and spread of INNS as a result of operation of Hornsea Three will not lead to a significant risk of hindering the achievement of the assumed conservation objectives for the features of the Markham's Triangle rMCZ (i.e. a general management approach of "maintain in favourable condition") for the following reasons:

- The **extents of the designated features** will not be affected by this impact; and

- The **structures and functions, quality and composition of characteristic biological communities** across the rMCZ will remain in a condition which is healthy and not deteriorating. While the introduction and spread of INNS may have effects on characterising faunal communities of the habitat features of Markham's Triangle rMCZ, including the composition and quality of these, the designed-in measures to be adopted as part of the project will minimise the risk of introduction and spread of INNS.

Alteration of seabed habitats arising from effects on physical processes, including scour effects and changes in the wave and tidal regimes within Markham's Triangle rMCZ

5.2.2.12 Volume 2, chapter 1: Marine Processes presents a detailed assessment of the changes to waves (in isolation and cumulatively), scour and tidal currents due to the presence of Hornsea Three infrastructure during the operational phase. These changes are summarised for impacts on benthic ecology receptors in volume 2, chapter 2: Benthic Ecology.

5.2.2.13 The presence of Hornsea Three would result in near-field changes to the tidal current only i.e. largely spatially limited to within the Hornsea Three array area, or the western portion of Markham's Triangle rMCZ and a narrow region just outside of the boundary (in the order of 4 km; see chapter 1: Marine Processes). Predicted maximum changes in current speeds vary from +0.04 ms^{-1} to -0.1 ms^{-1}. Baseline tidal currents across the former Hornsea Zone vary from approximately 0.6 ms^{-1} (at High Water) to 1 ms^{-1} (at Low Water) for peak mean spring tides and as such the existing tidal strength can be classified as moderately strong (McLeod, 1996). As outlined in volume 1, chapter 3: Project Description, scour protection will be installed around foundations to reduce scour. Cables and cable protection along the Hornsea Three offshore cable corridor and within the Hornsea Three array area will only exert a highly localised influence on the tidal regime.

5.2.2.14 For scour effects, across the Hornsea Three array area as a whole, the greatest total turbine foundation local scour footprint is associated with an array of 160 (15 m diameter) monopile foundations (724,801 m^2, equivalent to approximately 0.1% of the array area), while the greatest total turbine foundation global scour footprint is associated with an array of 342 smaller (32 m base diameter) piled jacket foundations (1,091,787 m^2, equivalent to approximately 0.16% of the array area).

5.2.2.15 The subtidal coarse sediment and subtidal sand habitat features of Markham's Triangle rMCZ are characteristic of areas subject to physical disturbance by weak to moderately strong tidal streams or as a result of wave action and have typically intermediate to high intolerance to large increases and decreases in flow rates (further discussed in volume 2, chapter 2: Benthic Ecology). The communities associated with these habitat features were considered to be of **medium** sensitivity to changes in flow rates, although the predicted changes were small (i.e. below the MarLIN benchmark levels used to assess the sensitivity of the receptors) and therefore the significance of effect was predicted to be **minor** adverse, which is not significant in MCAA terms.

5.2.2.16 Based on the information presented here, it can be concluded that the potential alteration of seabed habitats arising from changes in marine processes during operation of Hornsea Three will not lead to a significant risk of hindering the achievement of the assumed conservation objectives for the features of the Markham's Triangle rMCZ (i.e. a general management approach of "maintain in favourable condition") for the following reasons:

- The **extents of the designated features** will not be affected by this impact; and
- The **structures and functions, quality and composition of characteristic biological communities** across the rMCZ will remain in a condition which is healthy and not deteriorating, due to the small and highly localised changes predicted on marine processes.

5.2.3 Decommissioning Phase

Temporary habitat loss due to operations to remove inter-array cables, substation interconnector cables and jack-up operations to remove foundations within Markham's Triangle rMCZ

5.2.3.1 Effects of temporary habitat loss during the decommissioning phase within Markham's Triangle rMCZ are expected to be similar to those of the construction phase (see paragraph 5.2.1.1), although with a smaller area affected as this will not include seabed preparation for foundation installation. This will result in temporary habitat loss affecting a smaller area of up to 2,654,313 m^2 (see Table 5.7), equating to 1.32% of the area of the rMCZ, or 1.82% and 8.63% of the subtidal coarse sediment and subtidal sand habitat features, respectively. As noted in paragraph 5.2.1.2, due to the limited extent of subtidal sand within this part of the Hornsea Three array area (i.e. this habitat covers approximately 10% of the area of the rMCZ coinciding with the Hornsea Three array area; see Figure 4.2), the maximum proportion of the subtidal sand habitat feature predicted to be affected is considered to be highly conservative.

5.2.3.2 For the reasons outlined in paragraph 5.2.1.7, with respect to the conservation objectives of Markham's Triangle rMCZ, it can be concluded that there is no significant risk of temporary habitat loss/disturbance due to decommissioning activities hindering the achievement of the assumed conservation objectives for the features of the Markham's Triangle rMCZ.

Table 5.7: Temporary habitat loss within Markham's Triangle rMCZ during decommissioning phase. See maximum design scenario table of volume 2, chapter 2: Benthic Ecology for full description of maximum design scenario for Hornsea Three.

Project Element	Total habitat loss (m^2)	Assumptions (see maximum design scenario table of volume 2, chapter 2: Benthic Ecology for full description of Hornsea Three maximum design scenario)
Jack up footprints	163,653	Assumptions as per Table 5.4 (see volume 2, chapter 2: Benthic Ecology).
Inter array and substation interconnector cables	2,388,889	Assumptions as per Table 5.4 (see volume 2, chapter 2: Benthic Ecology).
Sandwave clearance	18,683	Assumptions as per Table 5.4 (see volume 2, chapter 2: Benthic Ecology).
Sandwave clearance disposal activities	35,310	Assumptions as per Table 5.4 (see volume 2, chapter 2: Benthic Ecology).
Anchor placements during cable installation	47,778	Assumptions as per Table 5.4 (see volume 2, chapter 2: Benthic Ecology).
Total temporary habitat loss	***2,654,313***	

Increases in SSC and deposition from removal of inter-array cables and foundations within Markham's Triangle rMCZ

5.2.3.3 Effects of increases in SSC and associated deposition due to removal of foundations and electrical cabling within Markham's Triangle rMCZ are expected to be similar, or smaller than those of the construction phase (i.e. as it will not include seabed preparation for foundation installation). As discussed in paragraph 5.2.1.12, with respect to the conservation objectives of Markham's Triangle rMCZ, it can be concluded that increases in SSC and associated deposition during the decommissioning phase will not result in a significant risk of hindering the achievement of the assumed conservation objectives for the features of the Markham's Triangle rMCZ.

Permanent habitat loss due to presence of scour/cable protection left in situ post decommissioning within Markham's Triangle rMCZ

5.2.3.4 The assessment of impacts during the Hornsea Three decommissioning phase assumes that all offshore infrastructure will be removed from the seabed with the exception of cable and scour protection which, it is currently assumed, will be left *in situ*. Hornsea Three will continue to discuss the need for, and feasibility of, removal of cable and scour protection in sensitive areas as the project progresses. Assessments will be updated accordingly to take account of any such discussions ahead of the final application.

5.2.3.5 Of the up to 646,180 m^2 long term habitat loss discussed in paragraphs 5.2.2.1 *et seq.*, up to 492,720 m^2 is comprised scour and cable protection and, for the purposes of this assessment, is assumed to be left *in situ*. This equates to approximately 0.34% of the subtidal coarse sediment habitat feature and 0.16% of the subtidal sand feature of Markham's Triangle rMCZ, based on the assumption that only 10% of 492,720 m^2 scour and cable protection will be placed in subtidal sand (see paragraph 5.2.1.2). Permanent loss of subtidal coarse sediment and subtidal sand habitat features of the Markham's Triangle rMCZ is predicted to be localised within the western area of the rMCZ, affecting only a small proportion of the habitat features. This impact will be continuous and irreversible and will affect the receptors directly resulting in a relatively small change in the baseline condition and therefore the magnitude was considered to be **minor**. The habitat features of the rMCZ are deemed to be of **high** sensitivity due to their high vulnerability with no potential for the recoverability. As such, the effect on the features of the Markham's Triangle rMCZ was predicted to be of **minor** adverse significance, which is not significant in MCAA terms.

Table 5.8: Permanent habitat loss within Markham's Triangle rMCZ during decommissioning phase.

Project Element	Total habitat loss (m^2)	Assumptions (see maximum design scenario table of volume 2, chapter 2: Benthic Ecology for full description of Hornsea Three maximum design scenario)
Scour protection from around foundations	322.697	Assumes maximum of 22% of scour protection associated with foundations within the Hornsea Three array area (see volume 2, chapter 2: Benthic Ecology).
Cable protection associated with inter array and substation interconnector cables	167,222	Assumptions as per Table 5.5 (see volume 2, chapter 2: Benthic Ecology).
Cable protection associated with cable/pipeline crossings	2,800	Assumptions as per Table 5.5 (see volume 2, chapter 2: Benthic Ecology).
Total long term habitat loss	***492,720***	

5.2.3.6 As discussed in paragraph 5.2.2.3, in addition to considering the potential for decommissioning of cable protection within the rMCZ, Hornsea Three area also considering the use of sensitive cable and scour protection measures which account for the local baseline seabed types, as these have the potential to limit the extent of any effects, allowing for recovery of habitats/communities in these areas both during the operational phase and following decommissioning. As the Project Description is further refined, the assessments presented within the PEIR shall be updated in the Environmental Statement to accompany the DCO.

5.2.4 Stage 1 Assessment Conclusion

5.2.4.1 Based on the information presented in the preceding sections, it can be concluded that there is no significant risk of Hornsea Three construction, operation and decommissioning hindering the achievement of the conservation objectives for Markham's Triangle rMCZ, as set out in section 4.2 (in accordance with s.125(2)(a) of the MCAA.

6. Next Steps

6.1.1.1 As detailed in paragraphs 1.1.1.2 and 5.1.1.1, this Shadow MCZ assessment should be considered as preliminary with respect to the conclusions regarding both the Cromer Shoal Chalk Beds MCZ and Markham's Triangle rMCZ. In relation to the Cromer Shoal Chalk Beds MCZ this is due to the uncertainties associated with the distribution and extent of habitat features within the section of the Hornsea Three offshore cable corridor which coincides with this MCZ, particularly subtidal chalk and peat and clay exposures. Details of spatial extent of peat and clay outcrops are currently being investigated by Hornsea Three. Figure 4.1 presents the spatial overlap of the offshore cable corridor geophysical survey extent with the protected features of the MCZ. The geophysical data shall be used to inform the final assessment and application by providing detailed information on the spatial extent of the interest features. Figure 4.1 also indicates the areas of the MCZ for which further information is currently being sought on the presence and extent of the subtidal chalk feature. The following information will be used to further refine the assessment on the protected features of the Cromer Shoal Chalk Beds MCZ:

- The proximity of the offshore cable corridor to habitat FOCI, particularly peat and clay exposures and subtidal chalk. As stated in paragraph 5.1.2.15, Hornsea Three is currently investigating the feasibility of avoiding these features and will seek to use this to mitigate these potential impacts, where possible, as the project evolves.
- The relative proportion of subtidal coarse sediments, subtidal mixed sediments and subtidal sand broadscale habitats which may be affected by cable installation (i.e. temporary habitat loss); and
- The levels of contaminants in sediments within the Cromer Shoal Chalk Beds MCZ.

6.1.1.2 Details on the distributions and extents of the MCZ habitat features along the offshore cable corridor will be informed by a benthic ecology survey within the MCZ to be undertaken in 2017. Once this further baseline data is collected within the Cromer Shoal Chalk Beds MCZ, this Shadow MCZ assessment will be updated and the findings presented to the MCZ Working Group for discussion prior to submission of the DCO application.

6.1.1.3 With regard to Markham's Triangle rMCZ, the assessment presented within this document can be considered with greater certainty due to the greater certainty with regard to the baseline environment, including the extents and distributions of the habitat features being considered. Any further refinements to the project description that are relevant to Markham's Triangle rMCZ will be incorporated into the final Shadow MCZ assessment which will accompany the DCO application.

7. References

Budd, G.C. (2008a) Nephtys cirrosa and Bathyporeia spp. in infralittoral sand. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme. Plymouth: Marine Biological Association of the United Kingdom. [cited 15/11/2013]. Available from: http://www.marlin.ac.uk/habitatsensitivity.php?habitatid=154&code=2004

Centre for Environment, Fisheries and Aquaculture Science (Cefas), Department for Environment, Food and Rural Affairs (Defra), Department of Trade and Industry (DTI) and Marine Consents and Environment Unit (MCEU) (2004) Offshore Wind Farms: Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements Version 2, Marine Consents Environment Unit, 48pp.

Chartered Institute of Ecology and Environmental Management (CIEEM) (2016) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal. Second Edition.

Covey, R. (1998) Chapter 6 Eastern England (Bridlington to Folkestone) (MNCR Sector 6). In: Marine Nature Conservation Review. Benthic marine ecosystems of Great Britain and the north-east Atlantic, ed. by K. Hiscock, 179–198. Peterborough, Joint Nature Conservation Committee (Coasts and seas of the United Kingdom. MNCR series).

De-Bastos, E.S.R. & Hill, J., (2016) Amphiura filiformis, Mysella bidentata and Abra nitida in circalittoral sandy mud. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://www.marlin.ac.uk/habitat/detail/368

De-Bastos, E. & Marshall, C.E. (2016) Mysella bidentata and Thyasira spp. in circalittoral muddy mixed sediment. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://www.marlin.ac.uk/habitat/detail/374

Defra (2015) Cromer Shoal Chalk Beds rMCZ Post-survey Site Report. Contract Reference: MB0120. Report Number: 34. Version 5. September 2015.

Defra (2014) Markham's Triangle rMCZ Post-survey Site Report. Contract Reference: MB0120. Report Number: 13. Version 6. November 2014.

Defra (2016a) Wildlife Environmental Protection Marine Management: The Cromer Shoal Chalk Beds Marine Conservation Zone Designation Order 2016, No.4.

Defra (2016b) Cromer Shoal Chalk Beds Marine Conservation Zone. Factsheet. 17 January 2016 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/492323/mcz-cromer-shoal-chalk-beds-factsheet.pdf

DONG Energy (2016) Hornsea Project Three Offshore Wind Farm. Environmental Impact Assessment: Scoping Report. October 2016, 481pp.

Durkin, O.C. (2008) Moerella spp. with venerid bivalves in infralittoral gravelly sand. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 15/11/2013]. Available from: http://www.marlin.ac.uk/habitatsensitivity.php?habitatid=388&code=2004

George, J.D., Chimonides, P.J., Evans, N.J., and Muir, A.I. (1995) Fluctuations in the macrobenthos of a shallow-water cobble habitat off North Norfolk, England. In: Biology and ecology of shallow coastal waters (Proceedings of the 28th European Marine Biology Symposium, Crete, September 1993), ed. by A. Eleftheriou, A.D. Ansell and C.J. Smith, 167–179. Fredensborg, Olsen and Olsen.

Highways Agency (2008) Design Manual for Roads and Bridges. London, DFT

Krone, R., Gutow, L., Joschko, T.J. and Schroder, A. (2013) Epifauna dynamics at an offshore foundation – Implications of future wind power farming in the North Sea. Marine Environmental Research. 85, 1-12.

Lindeboom, H.J., Kouwenhoven, H.J., Bergman, M.J.N., Bouma, S., Brasseur, S., Daan, R., Fijn, R.C., Haan, De d., Dirksen, S., Hal, R. van., Hille Ris Lambers, R., Hofsted, R ter., Krijgsveld, K.L., Leopold, M. and Scheidat, M. (2011) Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. Environmental Research Letters, 6 (3).

Marine Management Organisation (2013). Marine conservation zones and marine licensing. April 2013. Available at: www.gov.uk/government/uploads/system/uploads/attachment_data/file/410273/Marine_conservation_zones_and_marine_licensing.pdf.

Marshall, C.E. (2008) Sabellaria spinulosa on stable circalittoral mixed sediment. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 15/11/2013]. Available from: http://www.marlin.ac.uk/habitatbenchmarks.php?habitatid=377&code=2004.

Natural England (2016) Thanet Coast Marine Conservation Zone: conservation advice (UKMCZ0017). 29 January 2016.

Natural England (2017) Blackwater, Crouch, Roach and Colne Estuaries MCZ. Supplementary Advice, 20th March 2017.

Net Gain (2011) Final Recommendations Submission to Natural England & JNCC. Version 1.2, 31 August 2011

OSPAR (2008) Guidance on Environmental Considerations for Offshore Wind Farm Development. Reference Number 2008-3, 19pp.

Pinn, E.H., Thompson, R.C. and Hawkins, S.J. (2008) Piddocks (Mollusca: Bivalvia: Pholadidae) increase topographical complexity and species diversity in the intertidal Marine Ecology Progress Series, 355, pp. 173-182.

Spray, R. and Watson, D. (2011a [February]) North Norfolk's Chalk Reef, A report on marine surveys conducted by Seasearch East.

Spray, R. and Watson, D. (2011b [March]) North Norfolk's Chalk Reef, A report on marine surveys conducted by Seasearch East.

Tillin, H.M. & Rayment, W., (2016). Fabulina fabula and Magelona mirabilis with venerid bivalves and amphipods in infralittoral compacted fine muddy sand. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://www.marlin.ac.uk/habitat/detail/142

Tillin, H.M. (2016b) Moerella spp. with venerid bivalves in infralittoral gravelly sand. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://www.marlin.ac.uk/habitat/detail/1111

Tillin, H.M. (2016c) Polychaete-rich deep Venus community in offshore gravelly muddy sand. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://www.marlin.ac.uk/habitat/detail/1117

Tillin, H.M. & Hill, J.M., (2016) Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://www.marlin.ac.uk/habitat/detail/152

Tillin, H.M. & Marshall, C.M., (2015) Sabellaria spinulosa on stable circalittoral mixed sediment. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://www.marlin.ac.uk/habitat/detail/377

Watson, D. (2012) Cromer Shoal Chalk Beds Recommended MCZ. Seasearch Site Surveys 2012 for Marine Conservation Society.

Appendix A Example Stage 1 Assessment

A.1.1.1 As detailed in section 1.2 of the main report, prior to PEIR submission, two MCZ Workshops have been undertaken with relevant stakeholders, one in February 2017 and the second in May 2017. During the second of these workshops, Natural England highlighted that the methodology proposed (i.e. that summarised in section 2 and employed in section 5 of the main report) should be amended to assess each protected feature individually with consideration of attributes and targets for those features. Natural England highlighted that this approach would be clearer following issue of the conservation objectives for the Cromer Shoal Chalk Beds MCZ.

A.1.1.2 At the time of drafting of this MCZ assessment, the full conservation objectives for the Cromer Shoal Chalk Beds MCZ are currently being drafted by Natural England and have not been made available in time for PEIR production. As such the example stage 1 assessment presented here has been informed by the conservation objectives of the Thanet Coast MCZ. Following advice from Natural England, this MCZ was considered to be a useful proxy as it includes many of the same protected features as the Cromer Shoal Chalk Beds MCZ and therefore the conservation objectives would be expected to be similar to those currently being drafted by Natural England. This example stage 1 assessment has been presented to illustrate how the assessment could be undertaken for final MCZ assessment (subject to discussion with the MCZ working group and using the proxy conservation objectives here) once the conservation advice for the Cromer Shoal Chalk Beds MCZ is available.

A.1.1.3 In line with the Thanet Coast MCZ Supplementary Advice (Natural England, 2016) on conserving and restoring site features, specific consideration has been given to the individual attributes for each of the habitat features. These attributes are the ecological characteristics of the designated habitats within the site and are considered to be those which best describe the site's ecological integrity which, if safeguarded, will enable achievement of the Conservation Objectives. Each attribute has a quantitative or qualitative target (depending on available evidence), which identifies as far as possible the desired state to be achieved for the attribute, including whether the current objective is to 'maintain' or 'recover' the attribute.

A.1.1.4 The impact considered within this example, is 'temporary habitat loss/disturbance due to cable installation within the Cromer Shoal Chalk Beds MCZ'. The assessment of temporary habitat loss is equivalent to the following pressures identified for cable installation and burial as defined by Natural England's Advice on Operations for the Thanet Coast MCZ: *Abrasion/disturbance of the substrate on the surface of the seabed* and *Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion*. For the final MCZ assessment, the sensitivities of the relevant features (as presented in section 5 of the MCZ assessment) will also be updated to account for information presented in, and ensure consistency with, Natural England's Advice on Operations.

A.1.1.5 Each protected feature is discussed individually in the following tables, considering the specific attributes and targets for each feature (i.e. adapted from those of the Thanet Coast MCZ). It is expected that for the final Shadow MCZ Assessment, these tables will be more concise than those presented below, with much of the text on the specific attributes incorporated into the text of the main report. The tables presented within the final Shadow MCZ Assessment will then signpost the relevant paragraphs of text where each attribute is considered in the main report. For the purposes of this example the attribute tables have been compiled below, although final conclusions with respect to conservation objectives have not been made based on the attribute tables. The final MCZ assessment will include consideration of the attributes and targets of each protected feature when making conclusions with respect to "favourable condition" of those features (i.e. as set out in paragraph 4.2.1.5 of the main report for temporary habitat loss).

A.1.1.6 For the North Norfolk Coast assemblage of subtidal sediment features and habitats protected geological feature of the Cromer Shoal Chalk Beds MCZ, the attributes and targets have been adapted from the Blackwater, Crouch, Roach and Colne Estuaries MCZ (Natural England, 2017). It should be noted, however, that the protected geological feature of that MCZ (i.e. Clacton cliffs and foreshore) is considerably different to that of the Cromer Shoal Chalk Beds MCZ, although the definitions of "favourable condition" (see paragraph 4.2.1.6) are identical across the two MCZs. As with the habitat features of the Cromer Shoal Chalk Beds MCZ, following consideration of the attributes and targets of the protected geological feature, a conclusion will be made in the final MCZ assessment with respect to the "favourable condition" of the relevant features (e.g. paragraph 4.2.1.6 for temporary habitat loss).

A.2 Subtidal coarse sediments

Table A.1: Indicative attribute and targets for subtidal coarse sediment habitat feature. Note: attributes and targets are adapted from the Thanet Coast MCZ as the relevant information on conservation objectives are not currently available for the Cromer Shoal MCZ.

Attribute	Target	Supporting evidence to support Stage 1 Assessment
Extent and distribution	Maintain the total extent of subtidal coarse sediment at 148 km^2, and spatial distribution as defined on the map subject to natural variation in sediment veneer.	As detailed in paragraph 5.1.2.2, temporary habitat loss/disturbance has the potential to affect a maximum of 0.69% of this habitat within the MCZ. Only a small proportion of this habitat loss/disturbance will occur at any one time, with recovery of sediments and communities occurring following cable installation. Any effects on extent of this habitat will be temporary and reversible, affecting only a small proportion of the MCZ extent, with the total extent of this feature within the MCZ maintained following cable installation.
Structure: presence and abundance of typical species	[Maintain OR Recover OR Restore] the abundance of listed typical species, to enable each of them to be a viable component of the habitat.	Further information on typical species within this MCZ which should be considered in the assessment, is to be provided in the conservation objectives currently being drafted by Natural England. Notwithstanding this, as detailed in paragraph 5.1.2.8, it is expected that the species associated with this habitat feature would either rebury immediately following cable installation or recolonise disturbed sediment over time through larval settlement, with complete recovery expected within 5 years following cable burial. Abundances of typical species will therefore be maintained following construction, enabling them to be a viable component of the habitat.
Structure: species composition of component communities	Maintain the species composition of component communities.	Composition of component communities of subtidal coarse sediments will be unaffected across over 99% of the MCZ. Within the small proportion of the coarse sediments of the MCZ (i.e. 0.69% of this habitat feature), there will be localised reductions in species richness following cable burial operations. This will be as a result of increased predation of those species unable to rebury or direct injury/mortality of less robust species, and sessile epifaunal species. These effects will be localised and high recoverability of the species associated with this habitat following cable installation will result in some recovery within months of the impact and full recovery within up to five years. The species composition of the component communities will therefore be maintained following cable installation.
Distribution: presence and spatial distribution of subtidal coarse sediment communities	Maintain the presence and spatial distribution of subtidal coarse sediment communities.	The presence and spatial distribution of subtidal coarse sediment communities across the MCZ will not be affected by cable installation. Where temporary habitat loss/disturbance (and consequent localised loss of species diversity discussed above) occurs, these areas will be discrete areas where cables are installed (e.g. a linear cable trench less than 10 m width) and will not affect the communities outside these discrete areas. Following cable installation, the subtidal coarse sediment communities within the areas affected will recover to baseline levels, as discussed above. The presence and spatial distribution of component communities will therefore be maintained following cable installation.
Supporting processes: sediment movement and hydrodynamic regime	Maintain all hydrodynamic and physical conditions such that natural water flow and sediment movement are not significantly altered or prevented from responding to changes in environmental conditions.	While sediments (including coarse sediments) will be disturbed and mobilised during cable installation, any effects on sediment movement will be highly localised to the cable trench. Effects are also expected to be extremely short lived, with any localised effects on sediment movement only occurring during cable installation and returning quickly to baseline levels. The hydrodynamic regime will not be affected by cable burial operations.
Structure: sediment composition and distribution	Maintain the distribution of sediment composition types across the feature.	The distribution of coarse sediment across the MCZ will not be affected by temporary habitat loss/disturbance, with only a small proportion affected (i.e. a maximum of 0.69% of this habitat feature). As discussed in paragraph 5.1.2.3, in the small proportion of those areas where coarse sediments are affected, sediments from surrounding areas of seabed (i.e. coarse sediments) will infill the trench through wave and tidal action, with sediment composition returning to baseline levels following completion of cable burial.

A.3 Subtidal mixed sediment

Table A.2: Indicative attribute and targets for subtidal mixed sediment habitat feature. Note: attributes and targets are adapted from the Thanet Coast MCZ as the relevant information on conservation objectives are not currently available for the Cromer Shoal MCZ.

Attribute	Target	Supporting evidence to support Stage 1 Assessment
Extent and distribution	Maintain the total extent of subtidal mixed sediment at 49 km^2, and spatial distribution as defined on the map subject to natural variation in sediment veneer.	As detailed in paragraph 5.1.2.2, temporary habitat loss/disturbance has the potential to affect a maximum of 2.09% of this habitat within the MCZ. Only a small proportion of this habitat loss/disturbance will occur at any one time, with recovery of sediments and communities occurring following cable installation. Any effects on extent of this habitat will be temporary and reversible, affecting only a small proportion of the MCZ extent, with the total extent of this feature within the MCZ maintained following cable installation.
Structure: presence and abundance of typical species	[Maintain OR Recover OR Restore] the abundance of listed typical species, to enable each of them to be a viable component of the habitat.	Further information on typical species within this MCZ which should be considered in the assessment, is to be provided in the conservation objectives currently being drafted by Natural England. Notwithstanding this, as detailed in paragraph 5.1.2.8, it is expected that the communities associated with this habitat feature would rebury or recolonise disturbed sediment. Epifaunal species (including sessile species such as *Sabellaria spinulosa*, bryozoans and hydroids) are expected to have greater vulnerability to this impact, although recoverability is expected to be high (see paragraph 5.1.2.10). Recovery of typical species and communities is expected to start immediately following cable installation, with complete recovery expected within 5 years following cable burial. Abundances of typical species will therefore be maintained following construction, enabling them to be a viable component of the habitat.
Structure: species composition of component communities	Maintain the species composition of component communities.	Composition of component communities of subtidal mixed sediment will be unaffected across approximately 98% of the MCZ. Within the small proportion of the mixed sediments of the MCZ (i.e.2.09% of this habitat feature), there will be localised reductions in species richness following cable burial operations. This will be as a result of increased predation of those species unable to rebury or direct injury/mortality of less robust and particularly epifaunal species. These effects will be localised and high recoverability of the communities associated with this habitat following cable installation will result in some recovery within months of the impact and full recovery within up to five years. The species composition of the component communities will therefore be maintained following cable installation.
Distribution: presence and spatial distribution of subtidal mixed sediment communities	Maintain the presence and spatial distribution of subtidal mixed sediment communities.	The presence and spatial distribution of subtidal mixed sediment communities across the MCZ will not be affected by cable installation. Where temporary habitat loss/disturbance (and consequent localised loss of species diversity discussed above) occurs, these areas will be discrete areas where cables are installed (e.g. a linear cable trench less than 10 m width) and will not affect the communities outside these discrete areas. Following cable installation, the subtidal mixed sediment communities within the areas affected will recover to baseline levels, as discussed above. The presence and spatial distribution of component communities will therefore be maintained following cable installation.
Supporting processes: sediment movement and hydrodynamic regime	Maintain all hydrodynamic and physical conditions such that natural water flow and sediment movement are not significantly altered or prevented from responding to changes in environmental conditions.	While sediments (including mixed sediment) will be disturbed and mobilised during cable installation, any effects on sediment movement will be highly localised to the cable trench. Effects are also expected to be extremely short lived, with any localised effects on sediment movement only occurring during cable installation and returning quickly to baseline levels. The hydrodynamic regime will not be affected by cable burial operations.
Structure: sediment composition and distribution	Maintain the distribution of sediment composition types across the feature.	The distribution of mixed sediment across the MCZ will not be affected by temporary habitat loss/disturbance, with only a small proportion affected (i.e. a maximum of 2.09% of this habitat feature). As discussed in paragraph 5.1.2.3, in the small proportion of those areas where mixed sediments are affected, sediments from surrounding areas of seabed (i.e. mixed sediments) will infill the trench through wave and tidal action, with sediment composition returning to baseline levels following completion of cable burial.

A.4 Subtidal sand

Table A.3: Indicative attribute and targets for subtidal sand habitat feature. Note: attributes and targets are adapted from the Thanet Coast MCZ as the relevant information on conservation objectives are not currently available for the Cromer Shoal MCZ.

Attribute	Target	Supporting evidence to support Stage 1 Assessment
Extent and distribution	Maintain the total extent of subtidal sand at 18 km^2, and spatial distribution as defined on the map subject to natural variation in sediment veneer.	Temporary habitat loss/disturbance has the potential to affect a maximum of 5.70% of this habitat within the MCZ, assuming all temporary habitat loss occurs entirely within this habitat. As noted in paragraph 5.1.2.2 this highly precautionary as the sediments in the part of the MCZ which coincided with the Hornsea Three offshore cable corridor were found to largely comprise coarse and mixed sediments. As with the other habitat features, only a small proportion of this habitat loss/disturbance will occur at any one time, with recovery of sediments and communities occurring following cable installation (discussed below). Any effects on extent of this habitat will be temporary and reversible, affecting only a small proportion of the MCZ extent, with the total extent of this feature within the MCZ maintained following cable installation.
Structure: presence and abundance of typical species	[Maintain OR Recover OR Restore] the abundance of listed typical species, to enable each of them to be a viable component of the habitat.	Further information on typical species within this MCZ which should be considered in the assessment, is to be provided in the conservation objectives currently being drafted by Natural England. Notwithstanding this, as detailed in paragraph 5.1.2.9, it is expected that the communities associated subtidal sand sediments (i.e. infaunal species including polychaetes and venerid bivalves) would be capable of re-entering the substratum following disturbance or recovering into affected areas from surrounding undisturbed areas and larval dispersal. Recovery of species and communities associated with this habitat would be expected to be faster for coarse and mixed sediments, due to the lack of epifaunal species/communities, although full recovery may take a maximum of 5 years following cable burial. Abundances of typical species will therefore be maintained following construction, enabling them to be a viable component of the habitat.
Structure: species composition of component communities	Maintain the species composition of component communities.	Composition of component communities of subtidal sand will be unaffected across the vast majority of the MCZ (i.e. well over 95% of this habitat feature). Within the small proportion of subtidal sand in the MCZ (i.e. considerably less than the precautionary 5.7% estimated for this habitat feature), there will be localised reductions in species richness following cable burial operations. This will be as a result of increased predation of those species unable to rebury or direct injury/mortality of less robust species. These effects will be localised and high recoverability of the species associated with this habitat following cable installation will result in some recovery within months of the impact and full recovery occurring over a period months to years (maximum five years). The species composition of the component communities will therefore be maintained following cable installation.
Distribution: presence and spatial distribution of subtidal sand communities	Maintain the presence and spatial distribution of subtidal sand communities	The presence and spatial distribution of subtidal sand communities across the MCZ will not be affected by cable installation. Where temporary habitat loss/disturbance (and consequent localised loss of species diversity discussed above) occurs, these areas will be discrete areas where cables are installed (e.g. a linear cable trench less than 10 m width) and will not affect the communities outside these discrete areas. Following cable installation, the subtidal sand communities within the areas affected will recover to baseline levels, as discussed above. The presence and spatial distribution of component communities will therefore be maintained following cable installation.
Supporting processes: sediment movement and hydrodynamic regime	Maintain all hydrodynamic and physical conditions such that natural water flow and sediment movement are not significantly altered or prevented from responding to changes in environmental conditions.	While sediments (including sand) will be disturbed and mobilised during cable installation, any effects on sediment movement will be highly localised to the cable trench. Effects are also expected to be extremely short lived, with any localised effects on sediment movement only occurring during cable installation and returning quickly to baseline levels. The hydrodynamic regime will not be affected by cable burial operations.
Structure: sediment composition and distribution	Maintain the distribution of sediment composition types across the feature (and each of its subfeatures) (presence / absence of areas mapped in GIS), compared to an established baseline, to ensure continued structural habitat integrity and connectivity.	The distribution of subtidal sand across the MCZ will not be affected by temporary habitat loss/disturbance, with only a small proportion affected (i.e. considerably less than the precautionary 5.7% estimated for this habitat feature). As discussed in paragraph 5.1.2.3, in the small proportion of those areas where subtidal sand are affected, sediments from surrounding areas of seabed (i.e. sandy sediments) will infill the trench through wave and tidal action, with sediment composition returning to baseline levels following completion of cable burial.

A.5 Subtidal chalk

Table A.4: Indicative attribute and targets for subtidal chalk habitat feature. Note: attributes and targets are adapted from the Thanet Coast MCZ as the relevant information on conservation objectives are not currently available for the Cromer Shoal MCZ.

Attribute	Target	Supporting evidence to support Stage 1 Assessment
Extent and distribution	Maintain the total extent of subtidal chalk at 30 km^2, and spatial distribution as defined on the map subject to natural variation in sediment veneer.	As detailed in 5.1.2.4, assuming a maximum design scenario that cables are installed within the areas of subtidal chalk coinciding with the offshore cable corridor, this could result in loss/disturbance of up to 0.5% of this habitat feature within the MCZ (although it is noted that this estimate is highly conservative). While this loss/disturbance is expected to be irreversible, only a small proportion of this habitat within the MCZ will be affected. This habitat loss/disturbance will also be restricted to the western periphery of the subtidal chalk feature of the MCZ. The extent of subtidal chalk is expected to be subject to some variation over time, with mobile sediments within the MCZ exposing and burying areas of chalk (e.g. where these are not significantly elevated from the surrounding sediment) over time. The long term effect of this loss/disturbance (should this occur at all) on the extent of this habitat feature within the MCZ is therefore expected to be small. This assessment is likely to be highly conservative. Hornsea Three is currently investigating the feasibility of avoiding these features and will seek to use this to mitigate these potential impacts, where possible, as the project evolves. Assessment of effects on subtidal chalk features will be revisited prior to submission of the final Environmental Statement, as part of the DCO application.
Structure: presence and abundance of typical species	[Maintain OR Recover OR Restore] the abundance of listed typical species, to enable each of them to be a viable component of the habitat.	Further information on typical species within this MCZ which should be considered in the assessment, is to be provided in the conservation objectives currently being drafted by Natural England. As detailed in paragraph 5.1.2.11, typical species may include piddocks and other sessile epifaunal species (see section 4.2). In areas where cable installation coincides with subtidal chalk habitats, this will result in loss of species and individuals (including piddocks), with no potential for recovery in these discrete areas. These species within the vast majority of the subtidal chalk feature of the MCZ will be unaffected by cable installation, with any effects (should they occur at all) affecting the western periphery of the subtidal chalk feature within the MCZ.
Structure: species composition of component communities	Maintain the species composition of component communities.	Composition of component communities of subtidal chalk habitat feature will be unaffected across over 99.5% of the MCZ. Within the small proportion of this habitat feature within the MCZ (i.e. 0.5% of this habitat feature), there will be loss of component communities as chalk substrates are replaced by sediments which will infill disturbed areas following cable burial operations. These effects will be irreversible in areas where cable burial occurs (i.e. the western periphery of the subtidal chalk feature), although there is potential for some, if not complete recovery of communities in those areas affected by anchor placement, where the substrate is left intact, although this may be limited by, for example, reduction in structural complexity (see below).
Distribution: presence and spatial distribution of subtidal chalk communities	Maintain the presence and spatial distribution of subtidal chalk communities	The presence and spatial distribution of subtidal chalk communities will be affected by cable installation in the western periphery of the subtidal chalk feature within the MCZ. Where cable installation occurs, there will be a loss of communities associated with subtidal chalk within a linear cable trench of up to 10 m width. Anchor placement within subtidal chalk will affect discrete areas adjacent to the cable trench, with loss of species (particularly epifaunal species, but also potentially boring species such as piddocks) in these areas. However, in these areas, there is potential for recovery of species, depending on the level of damage to the substrate (e.g. structural complexity). Across the vast majority of the rest of the subtidal chalk habitats within the MCZ, no effects on the presence or spatial distribution of subtidal chalk communities will occur.
Structure: physical structure of rocky substrate	Maintain the surface and structural complexity, and the stability of the subtidal chalk.	In areas where cable burial occurs, both the surface and the structural complexity would be affected. As detailed above, in these areas, it is likely that the subtidal chalk substrates will be replaced with sediment substrates (e.g. coarse, sandy or mixed sediments) from the surrounding area with a loss of chalk habitat in these areas. The burial of cables within continuous areas of subtidal chalk may result in greater exposure of those areas of chalk immediately adjacent to the cable trench to wave and tidal action and sediment movement. Within areas where anchors are placed, it is likely that the surface of the chalk would be maintained, allowing for some recovery of associated communities in these areas. Depending on the structural complexity of those areas prior to anchor placement, a range of potential effects may occur, from relatively minor effects on complexity where the substrate is flat to significant reductions in complexity in areas where anchors come into contact with seabed features such as pinnacles, ridges or overhangs. The maximum proportion of this habitat feature which may be affected during cable installation is small in the context of the habitat across the MCZ and the area affected is along the western periphery of this feature within the MCZ. It should also be noted that this assessment is likely to be highly conservative. Hornsea Three is currently investigating the feasibility of avoiding these features and will seek to use this to mitigate these potential impacts, where possible, as the project evolves. Assessment of effects on subtidal chalk features will be revisited prior to submission of the final Environmental Statement, as part of the DCO application.

A.6 Peat and clay exposures

Table A.5: Indicative attribute and targets for peat and clay exposures habitat feature. Note: attributes and targets are adapted from the Thanet Coast MCZ as the relevant information on conservation objectives are not currently available for the Cromer Shoal MCZ.

Attribute	Target	Supporting evidence to support Stage 1 Assessment
Extent and distribution	Maintain the extent of peat and clay exposures [currently not defined for the Cromer Shoal Chalk Beds MCZ] and spatial distribution subject to natural variation in sediment veneer.	Peat and clay exposures have been recorded within the MCZ at discrete locations in the northwest of the MCZ, primarily outside the offshore cable corridor, although there are some historic records with are within it. As the exact extents of these have not been fully mapped, it is difficult to quantify the potential area affected by cable installation, or the relative proportions of this habitat within the MCZ that could be affected by cable installation. As discussed in paragraph 5.1.2.4, if cable burial occurs within this habitat, this will likely result in a change in the substrate, with sediments from surrounding areas (e.g. sand, coarse and mixed sediments) likely to infill any trench leading to a change to a sediment habitat. Any such change would likely be irreversible following cable installation. As with subtidal chalk, the extents and distribution of this habitat across the MCZ are likely to subject to some variation over time, with mobile sediments likely to expose or bury areas of clay and peat over time (e.g. where these are not significantly elevated from the surrounding sediment). This assessment is likely to be highly conservative. Hornsea Three is currently investigating the feasibility of avoiding peat and clay exposures and will seek to use this to mitigate these potential impacts, where possible, as the project evolves. Assessment of effects on peat and clay exposures will be revisited prior to submission of the final Environmental Statement, as part of the DCO application.
Structure: presence and abundance of typical species	[Maintain OR Recover OR Restore] the abundance of listed typical species, to enable each of them to be a viable component of the habitat.	Further information on typical species within this MCZ which should be considered in the assessment, is to be provided in the conservation objectives currently being drafted by Natural England. As detailed in paragraph 5.1.2.11, one of the key species in this habitat is piddocks (see section 4.2). In areas where cable burial occurs within peat and clay exposures, this will result in loss of species and individuals (including piddocks), with no potential for recovery in these discrete areas. In areas where anchor placement occurs, recovery is more likely, although the extent of recovery will be dependent on whether the substrate remains intact following anchor placement. It is likely that any effects on typical species of this habitat (should these occur at all) will be discrete and highly localised. This assessment is likely to be highly conservative. Hornsea Three is currently investigating the feasibility of avoiding peat and clay exposures and will seek to use this to mitigate these potential impacts, where possible, as the project evolves.
Structure: species composition of component communities	Maintain the species composition of component communities	Composition of component communities of the peat and clay exposures feature may be affected by cable installation, where direct impacts occur. In areas where cable burial occurs, this will lead to loss of the faunal communities associated with this habitat (i.e. sparse faunal communities characterised primarily by piddocks) with no potential for recovery, where substrate is removed and sediments infill the cable trench. In areas where anchors are placed, effects would be expected to be more limited, with some recovery potential where the substrate is retained.
Distribution: presence and spatial distribution of peat and clay communities	Maintain the presence and spatial distribution of peat and clay communities	Peat and clay exposures have historically been recorded in discrete locations in the northwest of the MCZ, with some of these records coinciding with the Hornsea Three offshore cable corridor. Should cable burial occur within these areas, there is potential for loss of this habitat feature, with consequent losses of associated communities and no potential for recovery due to changes in the seabed type from clay and peat substrates to a sediment dominated seabed (see paragraph 5.1.2.11). Hornsea Three is currently investigating the feasibility of avoiding peat and clay exposures and will seek to use this to mitigate these potential impacts, where possible, as the project evolves. The presence and spatial distribution of communities associated with peat and clay exposures across the MCZ will therefore be maintained, although losses may occur in discrete areas where cable burial is undertaken in these areas.
Structure: physical structure of rocky substrate	Maintain the surface and structural complexity, and the stability of the peat and clay exposures.	In areas where cable burial occurs within peat and clay exposures, both the surface and the structural complexity would be affected. As detailed above, in these areas, it is likely that the peat and clay exposures will be replaced with sediment substrates (e.g. coarse, sandy or mixed sediments) from the surrounding area with a loss of this feature in these areas. The burial of cables within continuous areas of subtidal chalk may result in greater exposure of those areas of chalk immediately adjacent to the cable trench to wave and tidal action and sediment movement. Within areas where anchors are placed, it is likely that the surface of the peat and clay would be maintained, allowing for some, or potentially full recovery of associated communities in these areas. Depending on the structural complexity of those areas prior to anchor placement, a range of potential effects may occur, from minor effects on complexity where the substrate is flat to reductions in complexity in areas where anchors come into contact with seabed features such as clay ridges. As discussed above, Hornsea Three is currently investigating the feasibility of avoiding peat and clay exposures and will seek to use this to mitigate these potential impacts, where possible, as the project evolves. Assessment of effects on the peat and clay exposures feature will be revisited prior to submission of the final Environmental Statement, when further information on the baseline environment is available.

A.7 North Norfolk coast assemblage of subtidal sediment features and habitats

Table A.6: Indicative attribute and targets for North Norfolk coast geological feature. Note: attributes and targets are adapted from the Blackwater, Crouch, Roach and Colne Estuaries MCZ as the relevant information on conservation objectives are not currently available for the Cromer Shoal MCZ.

Attribute	Target	Supporting evidence to support Stage 1 Assessment
Extent: extent of geological feature	Maintain the total extent of subtidal sediment features and habitats.	As detailed in Table A.1 to Table A.3 above, cable installation temporary habitat loss/disturbance during cable installation is predicted to affect only a small proportion of the component habitat and sediment features of the MCZ, with 0.32% of the area of the MCZ predicted to be affected by cable installation. Recovery of sediments will occur following cable installation with any effects on the extents of these component sediments or habitats predicted to be temporary and reversible. Cable burial in subtidal chalk is also predicted to affect up to a maximum of 0.5% of this habitat within the MCZ (Table A.4), although this proportion is likely to be highly precautionary. Should cable burial in this habitat occur, this will be at the western periphery of the subtidal chalk bed. Cable burial in this habitat feature would result in loss which is irreversible, with sediments likely to infill any cable trench, resulting in a change in substrate type. Effects of cable burial on peat and clay exposures would be similarly irreversible, being with areas affected by cable burial replaced by sediments from the surrounding area. Due to this feature occurring in discrete locations in the northwest of the MCZ, it has not been possible to make estimates of habitat loss or proportions of this habitat affected (see Table A.5). The extents of both these habitat types are known to be variable over time, with mobile sediments exposing or burying these features over time. It should be noted that this assessment is considered to be highly precautionary. Hornsea Three is currently investigating the feasibility of avoiding peat and clay exposures and will seek to use this to mitigate these potential impacts, where possible, as the project evolves. Any effects on these (where they occur at all) would therefore be limited in extent.
Extent of supporting geomorphological processes and associated sediments	Maintain the area of habitat which is likely to support the feature.	Cable burial operations will not impair the geomorphological processes which may support the sediment or rock features of the MCZ. Cable installation may have a limited effect on sediment movement while burial is taking place, although any such effects would be expected to be highly localised in extent and of short duration (i.e. during cable burial operations). As detailed in Table A.1 to Table A.3, cable installation will not affect the hydrodynamic regime either locally or across the wider MCZ.
Distribution: distribution of geological feature	Maintain the distribution of subtidal sediment features and habitats.	As detailed in Table A.1 to Table A.3 above, the distribution of subtidal sediment features of the MCZ will not be affected by cable installation. This will affect a small proportion of these sediment features in discrete areas (e.g. along a 10 m wide cable trench), although sediments will recover following cable installation with no effect on the distribution of these sediments across the MCZ. While there is potential for a small proportion of the subtidal chalk and peat and clay exposures features of the MCZ to be affected by cable installation (see Table A.4 and Table A.5). . Hornsea Three is currently investigating the feasibility of avoiding peat and clay exposures and will seek to use this to mitigate these potential impacts, where possible, as the project evolves. Any effects on these (where they occur at all) would therefore be limited in extent. Where cable installation occurs in subtidal chalk, these will occur on the western periphery of the main area of chalk habitat, although there is no recovery potential in these areas, with a likely change in seabed type from rock to sediment. Recovery would also not be expected in areas of clay and peat exposure where cables area buried with sediment likely to infill any cable trench. Where anchor placement occurs, the substrate would be liked to be retained, although there may be effects on the structural complexity of these features. Overall, it is likely that the overall distribution across the MCZ would be maintained, with small decreases in distribution in discrete areas.
Structure: structure of geological feature	Maintain the composition and integrity of sediments and rock features.	As detailed in Table A.1 to Table A.3 above, cable installation in subtidal sediment features of the MCZ will not affect the integrity or composition of the sediments. Although relatively small proportions of the sediment features will be disturbed during cable installation, these will be reworked by wave and tidal action, returning to baseline conditions following cable burial. While there is potential for a small proportion of the subtidal chalk and peat and clay exposures features of the MCZ to be affected by cable installation (see Table A.4 and Table A.5). . Hornsea Three is currently investigating the feasibility of avoiding peat and clay exposures and will seek to use this to mitigate these potential impacts, where possible, as the project evolves. Any effects on these (where they occur at all) would therefore be limited in extent. Cable burial in these areas may lead to changes in the seabed type, from subtidal chalk, peat or clay to sediment dominated seabed, with no potential for recovery. Where anchor placement occurs, the substrate would be liked to be retained, although there may be effects on the structural complexity of these features.