



Dudgeon and Sheringham Shoal Offshore Wind Farm Extensions

Preliminary Environmental Information Report

Volume 1

Chapter 4 - Site Selection & Assessment
of Alternatives

April 2021

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Glossary of Acronyms

BDC	Broadland District Council
BS	British Standard
BSI	British Standards Institution
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CIA	Cumulative Impact Assessment
DCO	Development Consent Order
DECC	Department for Energy and Climate Change
DEFRA	Department for the Environment and Rural Affairs
DEP	Dudgeon Extension Project
DMRB	Design Manual for Roads and Bridges
EC	European Commission
EIA	Environmental Impact Assessment
EPP	Evidence Plan Process
EPS	European Protected Species
EPUK	Environmental Protection United Kingdom
EQS	Environmental Quality Standards
ES	Environmental Statement
ETG	Expert Topic Group
EU	European Union
GIS	Geographical Information System
HRA	Habitats Regulations Assessment
HVAC	High-Voltage Alternating Current
HVDC	High-Voltage Direct Current
IPC	Infrastructure Planning Commission
IROPI	Imperative Reasons of Overriding Public Interest
ISO	International Standards Organisation
km	Kilometre
LPA	Local Planning Authority
MCZ	Marine Conservation Zone
MPA	Marine Protected Area
MW	Megawatts
NNDC	North Norfolk District Council

NorCC	Norwich City Council
NP	National Park
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Project
OS	Ordnance Survey
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
PEIR	Preliminary Environmental Information Report
PINS	Planning Inspectorate
PPG	Planning Practice Guidance
PRA	Preliminary Risk Assessment
SAC	Special Area of Conservation
SEP	Sheringham Shoal Extension Project
SNC	South Norfolk Council
SNS	Southern North Sea
SoS	Secretary of State
TEU	Treaty of the European Union
UK	United Kingdom
UN	United Nations
WTG	Wind Turbine Generator
ZVI	Zone of Visual Influence

Glossary of Terms

The Applicant	Equinor New Energy Limited
Dudgeon Offshore Wind Farm Extension site	The Dudgeon Offshore Wind Farm Extension lease area.
The Dudgeon Offshore Wind Farm Extension Project (DEP)	The Dudgeon Offshore Wind Farm Extension site as well as all onshore and offshore infrastructure.
DCO boundary	The area subject to the application for development consent, including all permanent and temporary works for DEP and SEP. The DCO boundary will be subject to updated impact assessment and further development of mitigation proposals to inform the ES.
Evidence Plan Process (EPP)	A voluntary consultation process with specialist stakeholders to agree the approach, and information to support, the EIA and HRA for certain topics.
Horizontal directional drilling (HDD) zones	The areas within the onshore cable route which would house HDD entry or exit points.
Jointing bays	Underground structures constructed at regular intervals along the onshore cable route to join sections of cable and facilitate installation of the cables into the buried ducts.
Infield cables	Cables which link the wind turbine generators to the offshore substation platform/s.
Interlink cables	Cables linking two separate project areas. This can be cables linking <ol style="list-style-type: none"> 1. DEP S and DEP N 2. DEP S and SEP 3. DEP N and SEP <p>1 is relevant if DEP is constructed alone or first in a phased development 2 and 3 are relevant in a tandem construction</p>
Landfall	The point on the coastline at which the offshore export cables are brought onshore and connected to the onshore export cables.
Onshore export cables	The cables which would bring electricity from the landfall to the onshore substation. 220 – 230kV
Onshore substation sites	Parcels of land within onshore substation zones A and B, identified as the most suitable location for development of the onshore substation. Two sites have been identified for further assessment within the PEIR.

Onshore Substation Zone	Parcels of land within the wider onshore substation search area identified as suitable for development of the onshore substation. Two substation zones (A and B) have been identified as having the greatest potential to accommodate the onshore substation.
Onshore cable corridor	The area between the landfall and the onshore substation sites, within which the onshore cable circuits will be installed along with other temporary works for construction.
Offshore export cables	The cables which would bring electricity from the offshore substation platform/s to the landfall. 220 – 230kV
Offshore substation platform	A fixed structure located within the wind farm site, containing electrical equipment to aggregate the power generated by the wind turbines and increase the voltage before transmitting the power to shore
PEIR boundary	The area subject to survey and preliminary impact assessment to inform the PEIR, including all permanent and temporary works for DEP and SEP. The PEIR boundary will be refined down to the final DCO boundary ahead of the application for development consent.
Sheringham Shoal Offshore Wind Farm Extension site	Sheringham Shoal Offshore Wind Farm Extension lease area.
The Sheringham Shoal Offshore Wind Farm Extension Project (SEP)	The Sheringham Offshore Wind Farm Extension site as well as all onshore and offshore infrastructure.
Study area	Area where potential impacts from the project could occur, as defined for each individual EIA topic.
Transition joint bay	Connects offshore and onshore export cables at the landfall. The transition joint bay will be located above mean high water

4 SITE SELECTION AND ASSESSMENT OF ALTERNATIVES

4.1 Introduction

1. This chapter of the Preliminary Environmental Information Report (PEIR) presents a description of the site selection process and the approach undertaken by Equinor (the Applicant) to define the Dudgeon Offshore Wind Farm Extension Project (DEP) and the Sheringham Shoal Offshore Wind Farm Extension Project (SEP). The process includes consideration of both the offshore and onshore infrastructure, and the assessment of reasonable alternatives as the proposals for DEP and SEP have developed through the pre-application process to date. This forms a vital stage of the wider Environmental Impact Assessment (EIA) process – to describe the reasonable alternatives considered during the evolution of the project (such as development design, technology, location, size and scale) and to set out the main reasons for selecting the chosen option/s.
2. The chapter outlines the site selection process and consideration of alternatives for DEP and SEP to date. The final outcomes will be confirmed in the Environmental Statement (ES) that will accompany the Development Consent Order (DCO) application.

4.2 Key Components of DEP and SEP

3. DEP and SEP will comprise the following main offshore components:
 - Wind turbines and their associated foundations;
 - Offshore substation platform/s (OSP/s) and associated foundation/s; and
 - Subsea cables and cable protection – offshore export cables, infield cables and interlink cables.
4. The main onshore components of DEP and SEP include:
 - Landfall
 - Up to two ducts installed under the beach at the landfall by Horizontal Directional Drilling (HDD).
 - Onshore cable corridor, including:
 - Onshore export cables laid within open cut trenches or installed in ducts, and associated infrastructure including transition bays, joint bays and link boxes;
 - Temporary construction access roads and haul roads;
 - Construction compounds; and
 - Trenched or trenchless crossing points at roads and sensitive features and habitats (e.g. sites designated for nature conservation).
 - Onshore substation, including:
 - Substation operational access road; and
 - Associated earthworks and / or landscaping associated with the onshore substation.
5. Further details of the key components of offshore and onshore infrastructure can be found in **Chapter 5 Project Description**.

4.2.1 Integrated approach to development

6. A key consideration in the site selection process is the intention to develop DEP and SEP as an integrated project, with an integrated grid option¹ providing transmission infrastructure which serves both of the wind farms.
7. As described in **Chapter 5 Project Description**, the strategic approach reflected by the integrated grid option particularly benefits the planning and construction of the electrical infrastructure system, is likely to reduce the overall environmental impact and disruption, and helps to respond to concerns regarding the lack of a holistic approach to offshore wind development in general.
8. As such, the site selection process, specifically the selection of the location of the OSP/s, offshore export cable corridor and all onshore infrastructure, has been driven by the consideration of co-locating infrastructure for both projects. By taking this approach the Applicant has demonstrably sought to reduce the overall levels of disruption during construction, therefore minimising the extent of potential environmental impacts.

4.3 Legislation, Policy and Guidance

9. The site selection process for offshore wind farms (OWFs) in the UK is governed by the existing legislative, policy and guidance framework for the development of electrical infrastructure and for environmental assessment within the UK (see **Chapter 3 Policy and Legislative Context** for more information). The key pieces of legislation, policy and best practice guidance which set the framework for site selection and the assessment of alternatives for OWFs in the UK, and upon which this methodology has been based, are summarised in **Table 4-1** below.

¹ The DCO application will seek consent for alternative grid solutions in the same overall corridors to allow for both the integrated grid option and, in the case that DEP and SEP are constructed in a phased approach, a separated grid option (i.e. transmission infrastructure which allows each project to transmit electricity entirely separately).

Table 4-1: Legislation, policy and guidance considered during the site selection and assessment of alternatives process

Legislation, Policy & Guidance	Details
Legislation	
Environmental Impact Assessment Regulations	<p>The consideration of alternatives and major design decisions made during the development of a project has been part of EIA Legislation since the adoption of the original EIA directive in UK law under the European Union (EU) EIA Directive 85/337/EEC (as amended by Directives 97/11/EC, 2003/35/EC and 2009/31/EC).</p> <p>The original Infrastructure Planning (Environmental Impact Assessment) Regulations (2009) required the applicant to provide <i>“an outline of the main alternatives studied by the applicant or appellant and an indication of the main reasons for his choice, considering the environmental effects”</i>.</p> <p>The new EIA Regulations (2017) update the wording slightly but do not significantly change the position. The 2017 Regulations require an ES to include <i>“a description of the reasonable alternatives (for example in terms of development design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects”</i>.</p>
The Electricity Act 1989	<p>Schedule 9 of The Electricity Act 1989 sets out the obligations for a generation installation to mitigate the effects on the environment, including <i>“shall have regard to...preserving natural beauty, of conserving flora, fauna and geological or physiographical features of special interest and of protecting sites, buildings and objects of architectural, historic or archaeological interest”</i>.</p> <p>In addition, Section 9 of the Act sets out the duties of an electricity distributor that are relevant to the site selection process, including that <i>“It shall be the duty of an electricity distributor to develop and maintain an efficient, co-ordinated and economical system of electricity distribution”</i>.</p>
The Planning Act 2008	<p>The Planning Act 2008 (as amended by the Marine and Coastal Access Act 2009, the Localism Act 2011, the Growth and Infrastructure Act 2013, and the Infrastructure Act 2015) is the primary legislation that established the legal framework for applying for, examining and determining applications for Nationally Significant Infrastructure Projects (NSIPs) taking into account the guidance in National Policy Statements (NPSs).</p>

Legislation, Policy & Guidance	Details
National Policy	
Overarching NPS for Energy (EN-1)	The Overarching NPS for Energy (EN-1) is clear that although “ <i>from a policy perspective this NPS EN-1 does not contain any general requirement to consider alternatives or to establish whether the proposed project represents the best option</i> ”, in the execution of a competent EIA “ <i>applicants are obliged to include in their ES, as a matter of fact, information about the main alternatives they have studied.</i> ”
Planning Inspectorate Advice Note Seven: EIA	The Planning Inspectorate Advice Note Seven suggests the EIA needs to explain “ <i>the reasonable alternatives considered and the reasons for the chosen option considering the effects of the Proposed Development on the environment</i> ”.
Guidance	
EIA Guide to Shaping Quality Development (IEMA)	<p>IEMA’s EIA Guide to Shaping Quality Development states that considering the key environmental and consenting risks alongside the engineering requirements of a project can influence design in many ways. The earlier the interaction commences, the more likely it is that cost effective, positive outcomes will be achievable. This can be considered in several ways:</p> <ul style="list-style-type: none"> • The review of site selection of alternative development sites to avoid key sensitive receptors; • Alternating the layout to work within a site’s existing natural systems; • Amending the design of a specific aspect of the development to manage impacts; • Specifying construction techniques to avoid effects on receptors; and • Changing materials to reduce volume and/or transport impacts.
The Horlock Rules	In order to identify the most appropriate location to site the onshore substation, National Grid’s Guidelines on Substation Siting and Design (‘The Horlock Rules’) (National Grid Company (NGC), 2006) are considered. These guidelines document National Grid’s best practice for the consideration of relevant constraints associated with the siting of onshore substations.

4.4 Site Selection Process and Consultation

10. The site selection and project design process is an iterative one, involving early engagement with stakeholders. Consultation and engagement with landowners, communities and regulators enables communication of the reasons for site selection decisions and allows for the feedback received to influence and refine the project design. Further details are provided in:
 - **Chapter 5 Project Description** – an overview of the consultation undertaken in the context of project design decisions;
 - **Chapter 6 EIA Methodology** – an overview of the consultation undertaken in the context of the wider EIA process; and
 - **Chapter 7 Technical Consultation** – summarises the consultation undertaken to inform and focus the approach to each technical aspect of the EIA. Specific details of how the project has taken account of the comments received are also provided in each chapter of the PEIR where relevant.
11. The siting, design and refinement of DEP and SEP have taken account of environmental, physical, technical, commercial and social considerations and opportunities as well as engineering requirements, with the aim of identifying sites that will be environmentally acceptable, deliverable and able to achieve consent, whilst also enabling, in the long term, benefits of the lowest energy cost to be passed onto the consumer. A multi-disciplinary design team was formed to undertake the site selection process, which included a team of specialists comprising engineers, planners, land advisors, legal and EIA / topic consultants, whose expertise was drawn upon throughout. **Plate 4-1** provides a flow diagram of the main steps in the site selection process.
12. The Applicant has undertaken pre-application engagement with stakeholders, communities and landowners in order to seek input to refine the DEP and SEP project design, and to communicate key decisions made with regard to both design and location.
13. Consultation on refinements to the DEP and SEP site selection, layout and configurations have been undertaken through the informal and formal pre-application stages to date. Feedback received has been taken into consideration throughout, through a range of means including (but not exclusively limited to):
 - The Scoping Report (November, 2019) sets out the development of the site selection and consideration of alternatives at the scoping stage (see section 1.4 of the Scoping Report). Consultation feedback was provided by stakeholders through the Planning Inspectorate (PINS) Scoping Opinion (PINS, 2019);
 - Public Information Day held at Aylsham Town Hall in October 2019;
 - Phase 1 consultation on site selection for the onshore substation and onshore cable corridor from 9th July to 20th August 2020, held online with statutory consultees and the public;

- Phase 2 public consultation for updates and feedback is planned for spring 2021 with statutory consultees and the public on the PEIR, including on the PEIR boundary and onshore substation sites;
 - Parish Council briefings;
 - Direct discussions with landowners, including:
 - The Applicant and the Applicant’s land agents have met the potentially affected landowners and/or their land agents. A number of PEIR boundary proposals have been put forward by those potentially affected by the proposed onshore development area and the Applicant has been able to incorporate a number of those suggestions into the proposed onshore development area boundary
 - The Applicant has engaged with landowners regarding survey access through consultation meetings. Letters were sent to all affected parties offering to meet to discuss the DEP and SEP proposals
 - Dedicated project e-mail address and freepost address to assist local communities in contacting the Applicant; and
 - Provision of a dedicated consultation website (<https://sepanddep.commonplace.is>) where interested members of the public are able to provide their comments via an interactive digital engagement platform.
14. **Table 4-2** details consultee responses to the first phase of consultation with statutory consultees and the public (held 9th July to 20th August 2020) undertaken prior to publishing this PEIR, pertaining to site selection and assessment of alternatives. The comments received have been taken into account in the development of the proposals so far, as described in the later sections of this chapter and throughout the PEIR.
15. The Applicant has also used an Evidence Plan Process (EPP) and has engaged through this process with a number of stakeholders on site selection matters. Several Expert Topic Groups (ETGs) have been established as part of the EPP to enable detailed discussions on particular topics. Details of the technical consultations undertaken are presented in **Chapter 7 Technical Consultation**.

Table 4-2: Consultation Responses Regarding Site Selection and Assessment of Alternatives.

Consultation	Feedback
Scoping Opinion (PINS, 2019)	<p>General</p> <ul style="list-style-type: none"> • The Scoping Report provides an overview on the main site selection activities undertaken to develop the scoping areas and a summary of the alternatives considered to date. References are made to environmental receptors which the Applicant has considered, although these are described at a very high level in relation to onshore site selection (section 1.4.4).

Consultation	Feedback
	<ul style="list-style-type: none"> The Inspectorate would expect to see a discrete section in the ES that provides details of the reasonable alternatives studied and the reasoning for the selection of the chosen option(s), including a comparison of the environmental effects. <p>Landfall</p> <ul style="list-style-type: none"> The Inspectorate notes that timely refinement of options will support a more robust assessment of likely significant effects and increase certainty for those likely to be affected. <p>Onshore Substation</p> <ul style="list-style-type: none"> The ES should identify whether new routes, either temporary or permanent, are required to access the onshore cable corridor and/or the temporary compounds. The likely significant effects of all temporary and permanent accesses should be included in the assessment scope. The onshore substation may connect to the existing Norwich Main substation through either an overhead connection or an underground connection, depending on their proximity to one another. The Inspectorate expects the ES to provide greater clarity as to the necessary connection works in order to inform a meaningful assessment of likely significant effects.
<p>Scoping Opinion (PINS, 2019)</p>	<p>Baconsthorpe Parish Council</p> <ul style="list-style-type: none"> Baconsthorpe Parish Council stressed preference for a ring main option to onshore cables to be investigated.
<p>Scoping Opinion (PINS, 2019)</p>	<p>Cawston Parish Council</p> <ul style="list-style-type: none"> Any application should include a full assessment of alternative methods of delivery onshore. In particular, an Offshore Ring Main would avoid the need for a series of cable corridors around Cawston.
<p>Scoping Opinion (PINS, 2019)</p>	<p>Marine Management Organisation</p> <ul style="list-style-type: none"> the Applicant has outlined their rationale for the landfall site selection, identifying the geographical exclusion of locations within the North Norfolk Coast Special Area of Conservation (SAC). Exclusion is on the basis that the SAC's condition status is Unfavourable. As such, the Applicant's two proposed landfall options pass through the Cromer Shoal Marine Conservation Zone (MCZ).

Consultation	Feedback
	<ul style="list-style-type: none"> • Whilst it is acknowledged that proposals passing through any Marine Protected Area (MPA) may be challenging, the MMO strongly recommends the Applicant investigate landfall options within the North Norfolk Coast SAC as an alternative route outside of Cromer Shoal Chalk Reef MCZ to a landfall site at Weybourne. The condition status of Unfavourable does not preclude cabling through the SAC as an option and could warrant further exploration. Detailed investigation would be required to assess the potential impacts specific to those protected features within the site in consideration of the conservation status of those specific features. This would offer a broader assessment of all landfall choices and support the Applicant’s overall evidence base and conclusions for the final cable route selection.
<p>Scoping Opinion (PINS, 2019)</p>	<p>Natural England</p> <ul style="list-style-type: none"> • Natural England prefers the integrated approach to electrical infrastructure option to reduce the overall amount of infrastructure, in particular the impacts caused by two distinct cable routes. • Natural England would welcome further detail on how environmental constraints have been considered in the site selection process. • Natural England asks the Applicant confirm that the removal of Race Bank Extension from the current leasing round will not open up the possibility that SEP might extend outside the scoping area as currently drawn (i.e. in the direction of the current Race Bank wind farm). • Natural England notes the decision to avoid routing potential cable corridors through the Wash and North Norfolk Coast SAC in light of its status being changed to unfavourable condition. However, the unfavourable condition of some site features doesn’t preclude the cable from going through the SAC. But, it does provide context in relation to any risk based judgements that may need to be made in relation to the significance of any impacts and thus mitigation measures required. • The Greater Wash SPA does not yet have an updated Conservation Advice package. It is therefore possible that before the Applicant applies for consent, a “reduce” target might also be set for the disturbance/displacement attribute within the

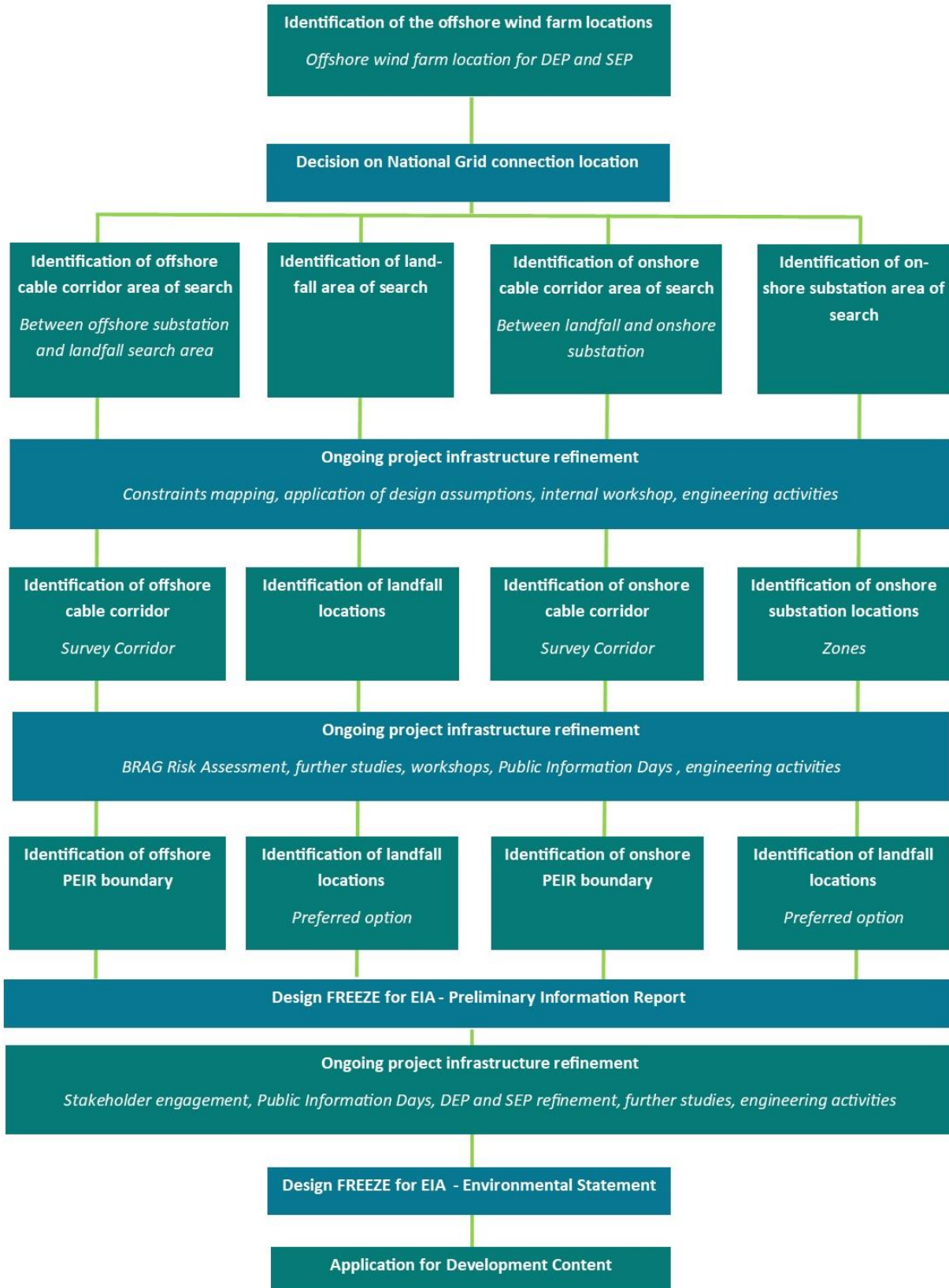
Consultation	Feedback
	<p>conservation objectives for the red-throated divers in the Greater Wash SPA.</p> <ul style="list-style-type: none"> • In seeking to minimise the potential impacts of the installation of the offshore export cables, the density maps of the bird features of the Greater Wash SPA should have been considered – in particular the density map for red-throated divers (Natural England & JNCC 2016). The shortest route, while minimising the footprint within the SPA does not necessarily minimise the potential impact to this feature. It is Natural England’s advice that cable protection is a permanent/long lasting impact not just during the lifetime of the project • Natural England disagrees that the wind farm extensions will not give rise to significant impacts on sea bed features. This is particularly relevant to the Cromer Shoal Chalk Beds MCZ and installing cables through it. The geological features that exist in this area are unique and cannot be reformed once damaged, unlike a mobile sediment dominated area. However, the effect on coastal morphology and sediment transport itself will probably be minimal.
<p>Phase 1 Consultations</p>	<p>General</p> <ul style="list-style-type: none"> • DEP and SEP should consider an Offshore Ringmain concept is fully reviewed. • Sheringham residents raise concern with regards to the additional turbines locations and their impact on seascape. • Residents stressed that DEP and SEP should avoid built-up areas and access. <p>Onshore Substation</p> <ul style="list-style-type: none"> • Residents raised concern that Substation Zone B is far too near Swardeston. • Residents stated that onshore substation must be located inland and not located on the coast. • Residents stressed that substation site should be close to A140. • Substation site selection should consider: Wildlife, building of houses in Colton, A47 dualling. • Substation site selection should consider: Road traffic must be considered and access, Cawston is not suitable for HGV. • Substation site selection should consider: Aquifers supplying local properties (many have well water supplies in the area), existing small rivers.

Consultation	Feedback
	<ul style="list-style-type: none"> • Substation site selection should consider: Landscape. • Substation site selection should consider: Effects on land drainage. Damage to soil structure and fertility. • Substation site selection should consider: Measured electromagnetic fields such as those produced by substations have been associated with health effects such as cancer, depression, dementia, infertility, miscarriage, heart problems, etc.
Phase 1 Consultations	<p>Oulton Parish Council</p> <ul style="list-style-type: none"> • DEP and SEP should consider an Offshore Ringmain concept is fully reviewed. • Oulton Parish Council stressed it is situated for all current projects as it is approximately 30km along the cable routes. The possibility of Oulton hosting yet another project's compound and storage areas, as well as a further cable route, would be completely unacceptable to this community. • Oulton Parish Council stated that the only cable route acceptable to this community would be an onshore cable trench shared with that of Hornsea Project Three.

16. Key project design decisions that have been made by the Applicant as a result of the consultation process and feedback received to date include:
- The intention to develop DEP and SEP as an integrated project with an integrated grid option providing transmission infrastructure which serves both of the wind farms. This benefits the planning and construction of the electrical infrastructure system, is likely to reduce overall levels of environmental impact and disruption, and helps to respond to any concerns regarding the lack of a holistic approach to offshore wind development.
 - Selection of the landfall at Weybourne with an export cable corridor through the western portion of the MCZ. This avoids the Wash and North Norfolk Coast SAC and reduces the overall length of the export cable corridor.
 - Commitment to no more than 100m of external cable protection per export cable in the MCZ, in relation to unburied cables. This reduces the extent of any longer term impacts on the MCZ.
 - Commitment to not using loose rock type external cable protection systems in the MCZ. This facilitates the possibility of removal on decommissioning.
 - Use of long HDD at the landfall in order to avoid works such as trenching on the beach and cliffs and the complete avoidance of the sensitive outcropping chalk feature in the nearshore portion of the MCZ.

- The location of the new onshore substation in proximity to the existing Norwich Main substation to minimise the proliferation of industrial infrastructure within the landscape.

Plate 4-1: Site Selection Process Overview



4.5 Project Alternatives

17. A number of strategic-level project design alternatives have been considered as part of the site selection and project design decision-making process. This strategic consideration of alternatives, which fed directly into the DEP and SEP site selection process, is detailed in **Table 4-3**.

Table 4-3: Strategic-level project design alternatives considered

Alternatives considered	Decision	Main Environmental Benefits
<ul style="list-style-type: none"> Integrated grid option; or Separated grid option. 	<p>The Applicant will seek to develop DEP and SEP as an integrated project, but with both options included in the application to allow for development in a phased approach, if necessary</p>	<p>The integrated grid option would:</p> <ul style="list-style-type: none"> Deliver benefits to the planning and construction of the electrical infrastructure system as a result of the co-location of infrastructure. Be likely to reduce the overall environmental impact and disruption.
<ul style="list-style-type: none"> A single application for development consent for DEP and SEP; or Separate consent applications. 	<p>A single development consent application to address both wind farms and the associated transmission infrastructure</p>	<p>Consistency in the approach to the environmental assessment, consultation and examination; reduced burden on stakeholders as only one application will be consulted on and subject to examination; and increased transparency for a potential compulsory acquisition process.</p>
<ul style="list-style-type: none"> Overhead lines along the ~60km route from landfall to grid connection location; or Buried onshore cables within ducts along the ~60km route from landfall to grid connection location. 	<p>Buried onshore cables within ducts</p>	<p>The environmental benefit of burying cables as opposed to overhead lines and pylons is a significant reduction of permanent visual impacts.</p>

Alternatives considered	Decision	Main Environmental Benefits
<p>Cable installation at the landfall:</p> <ul style="list-style-type: none"> • Long HDD exiting in the subtidal; • Short HDD exiting in the intertidal; or • Open trench cut with cofferdam/s. 	<p>Long HDD exiting in the subtidal</p>	<p>The environmental benefit of long HDD at the landfall removes any possible interaction with the Weybourne Cliffs Site of Special Scientific Interest (SSSI), avoids any impact on the outcropping chalk feature of the Cromer Shoal Chalk Beds MCZ (the HDD exit pits will be seaward of this feature) and reduces potential risks associated with coastal cliff erosion.</p>

4.6 Identification of the Offshore Wind Farm Location

18. The Applicant operates and part owns the existing Dudgeon and Sheringham Shoal OWFs, located off the North Norfolk coast in the southern North Sea (**Figure 4.1**). These wind farms were developed under The Crown Estate’s (TCE) Round 2 of UK offshore wind development and are both fully operational.
19. In February 2017, TCE issued a notice that it would accept applications for extensions to OWFs, with a deadline for submission of applications by the end of May 2018.
20. The Applicant submitted Agreement for Lease (AfL) applications to extend the Dudgeon and Sheringham Shoal OWFs. The AfL applications identified Areas of Interest (Aoi) for each of the proposed OWFs. Subsequently, TCE undertook a plan level Habitats Regulations Assessment (HRA) of all the OWF extension applications received, which was completed in August 2019 (TCE, 2019). The Offshore Wind Extensions Plan HRA Report to Inform an Appropriate Assessment (“RIAA”) and the Appropriate Assessment (“AA”) completed by TCE ascertained that the plan including DEP and SEP, would not have an adverse effect on the integrity of any European Site, either alone or in combination with other plans or projects. DEP and SEP were awarded seabed rights by TCE in August 2019 to progress the wind farm extensions and seek planning consent.
21. Key TCE criteria that influenced the site selection process included that wind farm extensions must share a boundary with the existing (parent) wind farm; and that other than the existing wind farm, the proposed extension/s must not encroach within a radius of 5km of any other wind farm (unless the tenant of any such wind farm had confirmed its agreement otherwise). The latter consideration limited the proposed boundary of the SEP wind farm site to the west due to an application to extend the Race Bank OWF from its eastern boundary. In addition, the TCE application criteria required that the proposed wind farm to be extended must be constructed and fully operational at the date of the application and the capacity in megawatts of the proposed extension must not exceed that of the existing wind farm. Equinor also took into account the requirement for the size of the proposed extension to be of an appropriate scale to the existing site, and to only apply for an area that was necessary and proportional to the installed capacity, taking account of necessary flexibility.

22. Equinor developed and applied the overarching site selection criteria outlined below:
- No nearer than 5km from the Race Bank OWF;
 - Avoid areas that are not feasible in terms of geology and bathymetry;
 - Minimise cable and pipeline crossings;
 - Distance to shore (no closer inshore than Sheringham Shoal OWF);
 - Water depths greater than 10m;
 - Avoiding existing shipping lanes and areas of high shipping density;
 - Maximise the benefits of the prevailing wind direction;
 - Minimise wake effects on operational wind farms;
 - Avoid wind farm area in marine nature conservation designations;
 - Minimise the disruption to existing infrastructure and other marine users;
 - Shortest route preference for cable routeing to reduce impacts, transmission losses and costs by minimising footprint for both the offshore and onshore cable routes;
 - Routeing options need to be able to connect to viable landfall locations; and
 - Avoidance of key sensitive features where possible and where not, seek to mitigate impacts.
23. The following sections describe how the site selection criteria were applied throughout the process.

4.6.1 Dudgeon Extension Areas of Interest Selection

24. At the AfL stage, applications were made for two distinct wind farm sites for DEP to provide the necessary flexibility and a sufficiently large area to achieve the required generating capacity. The AfL areas therefore comprise DEP North, an extension to the northwest and DEP South, an extension to the southeast (**Figure 4.1**).
25. Further to the TCE criteria outlined above, the key factors in the selection of the DEP North boundaries were:
- The northern boundary is defined by gas pipeline PL27 running between the Viking gas field in the east and the Theddlethorpe Gas Terminal on the Lincolnshire coast to the west, and diverts to avoid the Perenco-operated Waveney gas platform and its 500m safety zone.
 - The eastern boundary is defined by the Esmond to Bacton gas pipeline running between the Esmond gas field in the north and the Bacton Gas Terminal to the south on the Norfolk coast.
 - The western boundary is defined by a shipping lane between the existing Dudgeon and Sheringham Shoal OWFs as indicated by AIS data from 2016 and 2017 (further details in **Chapter 15 Shipping and Navigation**).

- A gap was left between DEP North and the existing Dudgeon OWF northern boundary to avoid potential conflict with a planned oil and gas development by Independent Oil and Gas Plc. Approvals are in place for installation and operation of a normally unmanned production platform, Blythe, and an additional subsea well, Elgood, to be tied back to Blythe. Elgood and Blythe would be located adjacent to the north eastern and eastern boundaries respectively of the Dudgeon OWF, connected by a production pipeline around the Dudgeon OWF boundary.
- A shallow area (part of Cromer Knoll sandbank) to the north west of the existing Dudgeon OWF was excluded from the DEP North boundary for technical reasons due to the shallow water depth and bathymetry, which were considered unsuitable for foundation and cable installation. In addition, Natural England advised (during a meeting held 29th January 2018) that this shallow area was believed to be important for feeding birds and that it would therefore be of benefit to exclude the area from development. Following the bathymetry analysis, engineering review and the advice from Natural England, this area was removed from the southern boundary of DEP North.

26. Key factors in the selection of the DEP South boundaries were:

- The shipping lane between the existing Dudgeon and Sheringham Shoal OWFs, limiting extension to the south and west.
- Although it was considered preferable to avoid the Esmond to Bacton gas pipeline, it traverses the DEP South wind farm site. Detailed design and layout of turbines will avoid the pipeline and infield cables will be arranged to minimise the number of pipeline crossings.

4.6.2 Sheringham Shoal Extension Area of Interest Selection

27. The key factors in the selection of the SEP boundaries were:

- Following submission of the application for AfL to TCE, the Applicant was informed of an application to extend the Race Bank OWF from its eastern boundary. Therefore, principles for the distance between the extensions were agreed with the Race Bank OWF developer (Ørsted) and TCE allowed the Applicant to redefine the extension boundary. The proposed western extension of Sheringham Shoal was limited in order to leave a 5km buffer from the proposed Race Bank OWF extension Aol in accordance with TCE's constraints criteria.

- The existing Sheringham Shoal OWF is located 17km north of the seaside town of Sheringham at its nearest point to the shore. Zones of Visual Influence (ZVIs) generated for the existing wind farm were studied, suggesting that the wind turbines are visible within 35km and that beyond this distance potential effects would not be significant. The Sheringham Shoal OWF Visual Impact Assessment showed that the wind farm is potentially visible from the North Norfolk coast between Brancaster in the west and Walcott in the east. Assessment of the closest coastal viewpoints between 17km and 19.5km distant suggested that the wind farm is visible 63% of the time, and decreases with increasing distance beyond these viewpoints (Scira Offshore Energy Ltd, 2006). An extension to the south and closer to shore than the existing wind farm was therefore ruled out to minimise potential visual impacts.
- The eastern boundary of SEP is defined by the route of the existing Dudgeon OWF export cables.
- The northern boundary of SEP is constrained by the shipping lane between the existing Dudgeon and Sheringham Shoal OWFs.

4.6.3 Wind Farm Extension AfL areas

28. Following the site selection process described above, and further refinement after discussion with TCE and stakeholders, the wind farm extension Aols were selected and included in the submitted AfL applications. The wind farm AfL boundaries are illustrated in **Figure 4.1**.

4.7 Grid Connection

29. National Grid is responsible for operating the electricity transmission network in England and Wales. The Connection and Infrastructure Options Note (CION) Process is the mechanism used by National Grid to evaluate potential transmission options to identify the connection point in line with their obligation to develop and maintain an efficient, coordinated and economical system of the electricity transmission network. As part of the economic assessment, the CION considers the total life cost of the connection – assessing both the capital and projected operational costs to the onshore network (over a project's lifetime) to determine the most economic and efficient design option.
30. Following the completion of the CION process, National Grid made a grid connection offer to the Applicant in April 2019 for connection at Norwich Main National Grid Substation, which would accommodate both DEP and SEP (see **Section 4.10** for further information). The Applicant accepted this offer in May 2019.

4.8 Offshore Export Cable Corridor and Landfall Site Selection

31. The offshore area surrounding the existing Sheringham Shoal and Dudgeon OWFs is complex, due to the numerous activities and environmental designations, as well as for technical reasons such as ground conditions. Based on the location of the DEP and SEP lease areas, and the location of the grid connection point at Norwich Main Substation, an initial search area for the landfall was established, covering the North Norfolk coastline from The Wash to Happisburgh. The process for identifying options for the landfall location then began with a comprehensive desk study analysis of coastline and offshore area. This included constraints mapping, site walkover and a series of workshops to understand the risks and challenges associated with different cable corridor and landfall options to rate and assess the different options. The evaluation included the following elements:
 - Environmental sensitivities and designations;
 - Length of the export cable corridor (offshore & onshore);
 - Crossing of offshore utilities and cables; and
 - Technical design and feasibility of the landfall location.
32. In early 2018, the Applicant was informed that the area designated as The Wash and North Norfolk Coast SAC was to be downgraded by Natural England to being considered in unfavourable condition, as a result of fisheries and OWF cable installation (Ørsted, 2018). The Applicant also had regard at this time to the emerging assessment outcomes and stakeholder advice in relation to Hornsea Project Three (e.g. Natural England, 2019a and Natural England, 2019b²). As such it was decided not to consider an export cable route through the SAC and to therefore to exclude this area from the landfall search area.
33. In addition to the desk study analysis described above, a site walkover from Weybourne in the west to Happisburgh in the east was undertaken by the Applicant's project team in January 2019, to consider cliff heights and other relevant constraints along the coastline that were otherwise not obvious from the desk based mapping study.
34. Cliff heights above 20m were considered to present a significant technical challenge to the engineering design of the landfall and so all areas with cliff heights above 20m were excluded from further consideration. The remaining areas of the North Norfolk coastline from The Wash to Happisburgh were assessed as to whether they would be suitable for landfall and the cable corridor, considering the distance from the wind farm sites, the extent of additional infrastructure that would be required, technical limitations and environmental sensitivities. Significant urban or otherwise built up areas were also excluded. Those landfall search areas were then either discounted or taken forward to the next stage of assessment.

² This document sets out Natural England's position on the potential effects of the proposed Hornsea Project Three OWF dated March 2019. This included that Natural England was unable to advise that an adverse effect on integrity could be ruled out for a range of factors, including the recent condition assessment, concerns with survey data and associated uncertainty in the impacts, the presence of possible cobble reef, permanent/lasting impacts from cable protection and concerns in relation to recovery from cable installation works.

35. At this stage, the following broad areas were identified for a potential landfall:
- Weybourne;
 - Bacton; and
 - Happisburgh.

4.8.1 Happisburgh Landfall Option

36. The offshore export cable corridor search area for Happisburgh could provide a cable corridor that avoids both the MCZ and SACs, however it is not a suitable or feasible alternative. The route to a landfall in the Happisburgh area is considerably longer than the routes to the other landfall options and a Happisburgh landfall would also add onshore length to the total export cable corridor route, therefore the footprint of potential impacts would be significantly larger for the overall development, onshore and offshore. A longer cable corridor would also significantly increase energy losses in comparison to the other routes. In addition, there is an increased number of records of Annex I *Sabellaria spinulosa* reef in this area, which would make the opportunity of micro-siting to avoid impacts more challenging.
37. With the construction of the Boreas and Vanguard cable routes and landfall at Happisburgh, it is considered that there is unlikely to be sufficient room to accommodate another landfall, due to the number of properties on the frontage along the stretch of coastline south of the Cromer Shoal Chalk Beds MCZ to Eccles on Sea. In addition, a landfall connection at Happisburgh would require multiple crossings of gas and chemical pipelines associated with the Bacton Gas Terminal (15 in total). This results in significant additional technical challenges and uncertainty, risks and constraints in addition to increased cost, and the long-lasting environmental impact of the crossing structures. There are also significant rates of erosion at Happisburgh which will not be protected by the Bacton Sandscaping Scheme, with the Shoreline Management Plan policy being for 'Managed Realignment' over the next 100 years. There are substantial stakeholder concerns in this regard and a dedicated community action group exists to try and reduce the erosion. A further project making landfall at this location was considered as being likely to cause further objections, as experienced by other recent proposals. For these reasons, the Happisburgh area of search was removed from further consideration at an early stage in 2019.

4.8.2 Weybourne and Bacton Landfall Options

38. Weybourne and Bacton were both taken forwards as landfall options into the EIA scoping process (**Figure 4.2**).

39. A key consideration in relation to the proposed HDD works was depth of burial and cable heating. The amount of power that can be transmitted through a cable is affected by how hot the cable is. Therefore, when considering cable design and what is currently technically feasible, consideration must be given to where the cables would need to be buried in such a way that would not allow heat to dissipate. At greater depths, cable rating would have to be reduced or would need a larger cross sectional area of cable to compensate, as it is harder for the heat to dissipate. With this in mind, Weybourne (near the existing Sheringham Shoal and Dudgeon OWF landfalls) was considered the most feasible option for the HDD landfall with previous successful drills and likely chalk bedrock encountered at around 20m below the seabed with sediment layers above (Lowestoft formation and beach sediments), identified by the 2008 geophysical seismic survey report which informed the original Dudgeon OWF landfall study. The HDD technique also requires no major construction works on the beach. This will limit any potential restrictions or closures to the beach and maintains access for the public.

4.8.3 Offshore export cable corridor identification for scoping

40. Following selection of the wind farm sites and potential landfalls, a process was undertaken to define the offshore export cable corridors to be taken forward to scoping. The offshore export cable corridor selection was driven through consideration of hard and soft environmental and engineering constraints between the wind farm sites and the landfall. The offshore export cable corridor search areas were determined primarily by the location of the potential landfalls, the position of the OWFs and OSP/s relative to those landfalls, and the need to have sufficient flexibility and width to avoid significant environmental, planning and development constraints.
41. Two offshore export cable corridor options linking the SEP wind farm site to shore were considered in further detail, one to Weybourne and one to Bacton. At each location two landfall options were considered:
- Bacton
 - East of Bacton Gas Terminals; and
 - West of Bacton Gas Terminals.
 - Weybourne
 - West – near to the existing Sheringham Shoal and Dudgeon OWF landfalls; and
 - East – between Sheringham and Weybourne.
42. Both offshore export cable corridor options exit the southern corner of the SEP wind farm site and must cross the existing Dudgeon offshore export cables and a shipping lane. Both offshore export cable corridor options also must cross the Hornsea Project Three export cable as it runs to the south of Dudgeon and Sheringham Shoal OWFs. Both corridor options must also cross the Cromer Shoal Chalk Beds MCZ and the Greater Wash Special Protection Area (SPA) to reach landfall. However, they both take a direct (and therefore shorter) route to shore through the designations to minimise their footprint within them.

43. The Weybourne corridor routes to the east and parallel to the existing Dudgeon offshore export cables to avoid unnecessary crossings. The export cable corridor north of the MCZ is approximately 500m wide and widens to approximately 1km wide upon entering the MCZ, and widens again towards the landfall area.
44. The Bacton corridor routes approximately 17km in a south easterly direction between shipping lanes before turning south before it meets the Shearwater to Bacton gas pipeline. It then routes parallel to the pipeline towards landfall north of the Bacton Gas Terminal and south of Mundesley. This route avoids crossing numerous pipelines linking southern North Sea gas production to the Bacton Gas Terminal. The corridor is approximately 500m wide for the majority of the route, but widens in the MCZ and before approaching landfall.

4.8.3.1 Designated site considerations

45. During a meeting with Natural England in January 2018, it was advised that a route close to the existing Dudgeon OWF export cables, passing through mixed subtidal sediment habitats, was preferred over any route through The Wash and North Norfolk Coast SAC, due to the potential impacts on Annex I habitats. In a further consultation meeting on 24th April 2019, Natural England advised that whilst it would be preferable for the export cable corridor to avoid the Cromer Shoal Chalk Beds MCZ, if this were not possible, the area should be fully characterised during the assessment phase to determine the presence of the features (habitats) of concern and the potential to avoid or minimise impacts on them.
46. A detailed benthic and geophysical survey of the export cable corridor has since been undertaken to identify the habitats present and to inform the impact assessments (see [Chapter 10 Benthic Ecology](#) and the [Marine Conservation Zone Assessment](#) for further details). Post construction surveys of the Sheringham Shoal OWF site showed likely recovery within two years in most areas (Fugro, 2013). By August 2020 epifaunal community structure along the export cable corridor had recovered such that it was not significantly different to unimpacted areas ([Section 10.6.2.1.2 in Chapter 10 Benthic Ecology](#) provides greater detail on the biotope recoverability) (Fugro, 2020).
47. The Applicant expects that further surveys will be undertaken prior to the start of construction to ensure that impacts on the benthic habitats and the MCZ can be avoided or minimised. As described in [Section 4.2](#), the Applicant has also committed to a long HDD at the landfall, which at Weybourne completely avoids the subtidal outcropping chalk MCZ feature, this is in a proven location for works of this nature on account of the successful HDD works already carried out for both Dudgeon and Sheringham Shoal OWFs.

4.8.4 Selection of offshore export cable corridor and landfall for PEIR

48. Following further refinement considering environmental and engineering constraints and the receipt of the Scoping Opinion (PINS, 2019) including Natural England's advice regarding the potential impacts on the features of Cromer Shoal Chalk Beds MCZ (see [Table 4-2](#)) and advice during consultation meetings; Weybourne was identified as the preferred landfall option for the offshore export cable corridor ([Figure 4.3](#) and [Figure 4.4](#)). The Weybourne landfall and offshore export cable corridor was selected on account of the following:

- Technical (i.e. engineering and design) advantages;
 - Considerably flatter topography (8m cliffs at Weybourne compared to 32m high cliffs at Bacton);
 - The total area impacted is minimised as a result of the shorter export cable route;
 - Good access using existing roads (Bacton would require a new access road);
 - It avoids the SSSI and any interaction with National Nature Reserves (NNR) along the Norfolk coast (e.g. Mundesley Cliffs SSSI and Paston Great Barn NNR);
 - It avoids the Annex I habitats of The Wash and North Norfolk Coast SAC which are in unfavourable condition (both Weybourne and Bacton landfall options avoid the SAC);
 - The ability of using a long HDD technique at the landfall to completely avoid the subtidal outcropping chalk MCZ feature (see [Table 4.2](#) and Natural England's advice regarding the potential impacts on the features of Cromer Shoal Chalk Beds MCZ). This is in a proven location for works of this nature (i.e. successful HDD works have already been carried out for both Dudgeon and Sheringham Shoal OWFs), whereas at Bacton it would not be possible to HDD under the full extent of the chalk, and the cable/s would encounter a further area of outcropping chalk offshore (Gardline, 2019);
 - Avoids the Bacton Sandscaping Scheme area, so there will be no interference with that scheme or potential cumulative impacts;
 - Located close to the existing Dudgeon and Sheringham Shoal HDD landfalls for which considerable experience, data and lessons learnt are available resulting in a high level of confidence in the engineering feasibility of landfall and HDD works at this location; and
 - Private land along the beach for duct preparation (as was used for example during the construction of the Dudgeon OWF).
49. Further to this, the detailed analysis of the two specific locations was considered at Weybourne; Weybourne West and Weybourne East. Weybourne East was excluded from further assessment on the basis of potential engineering constraints due to it having the greater elevation difference of the two locations and due to there being no history of an HDD landfall being performed in the area. In addition, National Trust raised concerns regarding Weybourne East and the potential for impacts on the National Trust land. Access to the drill site is also more challenging at this location than at Weybourne West, as such there would be increased disturbance for the local community due to the need to construct new roads and additional traffic movements (see [Appendix 4.2](#)).

50. In contrast, the Weybourne West landfall is located just east of the existing Dudgeon and Sheringham Shoal OWF landfalls, to the west of Weybourne beach car park at the Muckleburgh Military Collection. It has a lower and more favourable elevation (see **Appendix 4.2**) and better access. Ground investigation data including a geophysical seismic survey and boreholes carried out for the Dudgeon OWF and the January 2019 site walkover were used to confirm the suitability of this site as the landfall for DEP and SEP.
51. As a result and in conjunction with the landfall considerations set out above, the offshore export cable corridor to Weybourne (with landfall at Weybourne West) was selected and taken forward as the basis for more detailed assessment within the PEIR.

4.9 Onshore Cable Corridor Selection

52. In parallel with the identification of the landfall location, a process to identify the onshore cable corridor was undertaken. This process initially involved the identification of an onshore cable corridor between both potential landfall locations (i.e. Weybourne and Bacton) and the grid connection point at Norwich Main.
53. As described earlier, in order to minimise permanent visual impacts during the operational life of DEP and SEP, the onshore cables between the landfall and the electrical connection point would involve a new underground (buried) cable system rather than any new overhead lines.
54. Key principles that informed the cable corridor site selection exercise included:
- Preference for shortest onshore cable to minimise the overall footprints and the number of receptors that will be affected;
 - Avoid key sensitive features, where possible; and
 - Avoid populated areas, where possible.
55. The cable corridor site selection exercise has specifically taken into account the following constraints:
- Sites designated for nature conservation (e.g. SPA, Site of Special Scientific Interest (SSSI));
 - Sites designated for their landscape (e.g. AONB);
 - Historic designations (e.g. listed building or scheduled monuments);
 - Residential properties;
 - Flood zones / Source Protection Zones (SPZ);
 - Contaminated land; and
 - Other infrastructure (e.g. buried cables, railways, roads).

4.9.1 Onshore Cable Corridor – Search Areas

56. The first step in the site selection process was the identification of a broad cable corridor search area (3km in width). The cable corridor search area was identified using the guiding principles as listed in **Section 4.9**, initially along a straight-line approach, avoiding Norwich. A buffer of 3km was also placed around the National Grid connection location at Norwich Main, to create a substation search area (the onshore substation site selection is presented in **Section 4.10**). These areas were both developed using high level design principles (for example avoiding unsuitable ground conditions, access challenges, watercourse and road crossings etc.) and taking into account the constraints listed above. Three corridors as presented were identified based upon the high level design principles listed above:
- Search Area Option 1 with a landfall at Weybourne and a north to south corridor passing to the west of Norwich;
 - Search Area Option 2 with a landfall at Bacton the onshore cable corridor heads east to west before joining the Option 1 route and heading south; and
 - Search Area Option 3 also has a landfall at Bacton. This option headed more directly towards Norwich in a south westerly direction crossing the northern edge of the Broads National Park. This option was dropped from further consideration after early consultation in May 2019 to avoid impacts on the Broads National Park.
57. An initial feasibility and further route refinement exercise was undertaken on the two remaining 3km wide cable corridor search areas in June 2019. The output from this was the identification of two 1km wide onshore cable corridors: one based on a Weybourne landfall; and one based on a Bacton landfall. These two corridors were taken forward for consultation and presented within the scoping report submitted in October 2019 (**Figure 4.5** and **Figure 4.6**).

4.9.2 Onshore Cable Corridor – PEIR Stage

58. As described in **Section 4.8**, Weybourne was selected as the preferred landfall location in early 2020 and therefore ongoing refinement of the onshore cable corridor for the PEIR focused on the 1km wide onshore cable corridor route between Weybourne and Norwich Main substation. Further refinement of the route following the scoping stage has been informed by a process of information gathering, including:
- Responses from the local community during the Phase 1 Consultation (9th July to 20th August 2020);
 - Completion of an engineering feasibility study;
 - Discussions with landowners along the onshore cable corridor route;
 - Additional desk-based data collection, such as utilities data and publicly available geological records;
 - Further environmental surveys, including Extended Phase 1 Habitat Survey and Archaeological Geophysical Survey; and
 - Ongoing technical engagement with key stakeholders, including other developers in the area.

59. The exercises listed above sought to narrow the width of the onshore cable corridor to 200m for the purposes of assessment within the PEIR. This involved a series of workshops involving multiple workstreams within the Applicant's project team to work through the information available and determine the best possible route based on the key principles set out in **Section 4.9** of this chapter. Responses received during the Phase 1 Consultation and landowner comments were each considered individually. In some instances these comments resulted in a direct change to the alignment of the 200m wide route, however in some cases the responses received could not be implemented, or will be considered again at the next stage of refinement (see **Section 4.9.3**).
60. The Consultation Report submitted with the DCO application will include a response to all feedback received on the proposed alignment of the onshore cable corridor. The purpose of defining a 200m wide onshore cable corridor at this stage is to allow for more targeted surveys to be undertaken (particularly species specific ecology surveys), and to retain sufficient flexibility to take into account stakeholder feedback during the phase two consultation. Furthermore, whilst the majority of the route has been reduced to a 200m wide corridor, a number of challenging sections currently include a wider area whilst more detailed engineering feasibility work is undertaken. These areas include:
- The landfall location at Weybourne;
 - Weybourne woods; and
 - North of Cawston.
61. Refinement of the 200m wide corridor for the PEIR boundary also involved identifying construction access points for early works, aligning the cable corridor where possible with field boundaries, and clipping the onshore cable corridor and access points to land registry boundaries. The PEIR boundary showing the 200m wide onshore cable corridor is shown on **Figure 4.8**. The overall benefits of the onshore cable corridor refinement process to date include:
- A reduced number of potentially affected landowners;
 - Key sensitive habitats and features avoided where possible;
 - A route that is feasible from an engineering and constructability perspective (including flexibility in some areas for further investigations); and
 - A comprehensive set of data and information from which to refine the route further for the DCO application.

62. Weybourne was identified as the preferred landfall location in 2020 and ongoing cable corridor site selection activities only considered Option 1 of the three cable corridor options that had been identified in 2019. Further consideration of the 1km wide cable corridor was undertaken, taking into account further engineering feasibility, landowner discussions and initial survey findings (**Figure 4.7**). The exercise sought to narrow the width of the corridor for assessment purposes down to typically 200m. This would allow more targeted surveys to be undertaken, and retain sufficient flexibility to take into account stakeholder feedback and detailed survey findings to inform the preferred DCO application boundary (up to 60m wide). Whilst the majority of the route could be reduced to a 200m wide corridor, a number of complex locations have retained a wider search area at this stage whilst more detailed engineering feasibility work is undertaken. These areas include:
- Weybourne landfall location;
 - Weybourne woods;
 - River Wensum crossing;
 - A47 crossing; and
 - Onshore substation at Norwich Main.
63. The PEIR boundary was further refined to remove features such as clipped land registry boundaries, road margins, access tracks and areas of sensitive habitats, whilst still maintaining up to 200m cable corridor width (where possible) to allow for engineering flexibility. The overall benefits of the cable corridor review process included:
- Reducing the number of potentially affected landowners;
 - Avoiding direct impacts to a number of sensitive habitats and features;
 - Reviewing the engineering feasibility and constructability; and
 - Identifying potential cable pinch points.
64. The final PEIR boundary is shown on **Figure 4.8**.

4.9.3 Onshore Cable Corridor – DCO Application

65. Following phase two consultation, the onshore cable corridor will be further refined to a width of 60m for the DCO application, increasing to a width of 100m for trenchless crossing zones, such as main rivers and A roads. This will be informed by phase two consultation feedback, as well as further landowner engagement, technical studies and ongoing environmental survey and assessment work. As previously noted, any earlier relevant comments received on the onshore cable corridor (for example during the phase one consultation) will be reviewed again as part of this process.
66. In determining the width of the onshore cable corridor consideration has been given to the project development scenarios under consideration and the need to allow for space within the onshore cable corridor for micro-siting of construction elements (including the cables themselves) should additional constraints be identified at a later stage of DEP and SEP.

67. Within the final onshore cable corridor areas for construction compounds will also be identified. Temporary construction compounds are required to support the onshore cable installation. This will include several secondary compounds along the onshore cable corridor, and up to two main compounds for project offices, welfare facilities, staff parking, and material and equipment storage. We are still in the process of identifying locations for the main construction compound(s). More information on the site selection process for this element of the onshore cable corridor is provided the DEP and SEP phase two consultation material, provided separately to this PEIR.

4.10 Onshore Substation

68. As described in **Section 4.7**, following the completion of the CION process, National Grid made the Applicant a grid connection offer in April 2019 for connection at Norwich Main National Grid Substation, which would accommodate both DEP and SEP. This offer was accepted by the Applicant in May 2019, and therefore the location of Norwich Main substation formed the basis for the onshore substation site selection work.
69. DEP and SEP will require the construction of an onshore substation that will accommodate both DEP and SEP. Some of the onshore substation infrastructure will be shared between DEP and SEP and the number of buildings required would be the same whether one or both projects are progressed.
70. The onshore substation site selection exercise has specifically taken into account the following constraints (please see **Appendix 4.1** for more information):
- Residential properties + 250m buffer;
 - Special Protection Areas;
 - Special Area of Conservations;
 - Ramsar sites;
 - Areas of Outstanding Natural Beauty;
 - Sites of Special Scientific Interest;
 - Local Nature Reserves;
 - National Nature Reserves;
 - County Wildlife Sites;
 - Registered Parks and Gardens;
 - Ancient Woodland;
 - RSBP reserves;
 - National Trust land;
 - Common land;
 - Public Rights or Way;
 - Main Rivers;
 - Flood Zones 2 & 3;
 - Scheduled Monuments;
 - Conservation Areas;
 - Listed buildings;

- Historic Environment Records;
- Historic landfill sites;
- Source Protection Zones;
- Existing National Grid infrastructure including overhead lines; and
- The DCO limits of other NSIPs (including Hornsea Project Three).

4.10.1 Horlock Rules

71. In order to identify the most appropriate location to site the onshore substation, National Grid’s Guidelines on Substation Siting and Design (The Horlock Rules) have been taken into consideration. These guidelines document National Grid’s best practice for the consideration of relevant constraints associated with the siting of substations. The Horlock Rules have been considered as part of the development of the onshore substation location, as outlined within **Table 4-4**.

Table 4-4: Horlock Rules

National Grid’s Approach to Design and Siting Substations (Overall System Options and Site Selection)	Onshore substation considerations for the project
<p>In the development of system options including new substations, consideration must be given to environmental issues from the earliest stage to balance the technical benefits and capital cost requirements for new developments against the consequential environmental effects, in order to keep adverse effects to a reasonably practicable minimum.</p>	<p>Environmental constraints and opportunities will be considered throughout the site selection phase.</p>
Amenity, Cultural or Scientific Values of Sites	
<p>The siting of new National Grid Company substations, sealing end compounds and line entries should as far as reasonably practicable seek to avoid altogether internationally and nationally designated areas of the highest amenity, cultural or scientific value by the overall planning of the system connections.</p>	<p>Internationally and nationally designated sites will be avoided (where possible), for example, some of the designations which will be considered include National Parks; AONB; Heritage Coasts; World Heritage Sites; Ramsar Sites; SSSIs; NNRs; SPAs; and/or; SACs.</p> <p>In addition, consideration will also be given to historic sites with statutory protection (such as onshore archaeology and cultural heritage).</p>

National Grid's Approach to Design and Siting Substations (Overall System Options and Site Selection)	Onshore substation considerations for the project
Local Context, Land Use and Site Planning	
<p>Areas of local amenity value, important existing habitats and landscape features including ancient woodland, historic hedgerows, surface and ground water sources and nature conservation areas should be protected as far as reasonably practicable</p>	<p>Areas of local amenity value in the location of the onshore substation will be protected as far as reasonably practicable as part of the site selection process. Consideration will be given to existing habitats and landscape features including ancient woodland historic hedgerows, surface and ground water sources and nature conservation areas (e.g. County Wildlife Sites).</p>
<p>The siting of substations, extensions and associated proposals should take advantage of the screening provided by land form and existing features and the potential use of site layout and levels to keep intrusion into surrounding areas to a reasonably practicable minimum.</p>	<p>The onshore substation locations will consider the benefits from enclosed or discreet landform or relatively substantial existing hedgerows and woodland blocks within the local area which can provide a level of mitigation of landscape and visual effects from the outset and can be strengthened with planting proposals during the construction phases of the proposed project to ensure robust screening.</p>
<p>The proposals should keep the visual, noise and other environmental effects to a reasonably practicable minimum.</p>	<p>Visual, noise and other environmental effects will be minimised as far as possible through the site selection process. For example, consideration will be given to existing screening and locating the onshore substations away from built up and residential areas.</p>
<p>The land use effects of the proposal should be considered when planning the siting of substations or extensions.</p>	<p>The effects on land use will be considered as part of the site selection process, with modified landscapes being considered as more favourable sites than natural or semi-natural landscapes.</p>

National Grid's Approach to Design and Siting Substations (Overall System Options and Site Selection)	Onshore substation considerations for the project
Design	
<p>In the design of new substations or line entries, early consideration should be given to the options available for terminal towers, equipment, buildings and ancillary development appropriate to individual locations, seeking to keep effects to a reasonably practicable minimum.</p>	<p>Landscape and visual impact will be minimised by avoiding the use of tall structures and buildings and exploring options to introduce mitigation measures wherever possible. The onshore project substation will be subject to detailed design post consent.</p>
<p>Space should be used effectively to limit the area required for development consistent with appropriate mitigation measures and to minimise the adverse effects on existing land use and rights of way, whilst also having regard to future extension of the substation.</p>	<p>The permanent footprint for the onshore project substation is based on maximum preliminary layouts for purposes of assessment. More space-efficient solutions may be developed during the detailed design process; if so, this would reduce the area required for development.</p>
<p>The design of access roads, perimeter fencing, earth shaping, planting and ancillary development should form an integral part of the site layout and design to fit in with the surroundings.</p>	<p>The design of access roads, perimeter fencing, earth shaping, planting and ancillary development will be subject to final detailed design, however these will be designed in accordance with principles of a Design and Access Statement (DAS) and will look to reflect the character of the local landscape as best as practically possible.</p>
Line Entry	
<p>In open landscape especially, high voltage line entries should be kept, as far as possible, visually separate from low voltage lines and other overhead lines to avoid a confusing appearance.</p>	<p>All cables to the connection point will be buried underground. The design approach taken would be confirmed at detailed design phase, post consent but would be in keeping with the existing substation design.</p>

4.10.2 Onshore Substation – Substation Zones

72. Following the identification of Norwich Main as the grid connection point, an exercise was undertaken to identify areas with the greatest potential to accommodate the proposed permanent above ground infrastructure, taking into account the design assumptions and site selection principles combined with environmental constraints mapping based on publicly accessible environmental datasets, including environmental receptors and in some instances associated buffers.
73. The guiding design and site selection principles for locating the onshore substation were to identify an economic and efficient connection (i.e. as close as possible to the connection point) whilst taking into account environmental constraints and available space as defined above.
74. Those areas with the fewest constraints and therefore the greatest potential to avoid impacts were identified as potential substation zones for further consideration. Nine zones were identified within the 3km buffer (A-I) as shown in **Figure 4.9**.
75. A comparative assessment of these zones was then undertaken to further determine which zones had the greatest potential to accommodate the proposed infrastructure. This considered the maximum and minimum distance of separation from the nearest properties and other sensitive receptors that could be achieved for each substation zone, as well as associated engineering constraints such as the maximum and minimum total length of buried cabling required to connect the substation to Norwich Main and the how many challenging crossings (roads, railways, rivers, etc) might be required to achieve connections within each zone. The nine zones were ranked from least preferred to most preferred on a scale of 1 to 9.
76. This exercise identified that zones A, B, C, D and E had relatively greater opportunity to accommodate the proposed infrastructure compared to zones F, G, H and I.
77. Within each of the five preferred zones (A-E) visual heat maps were produced to better identify areas within each zone that were comparatively more or less preferred for potential locations of substations. Using this as a guide, and in combination with aerial imagery to better understand the locations of field boundaries etc, potential locations (fields) that could accommodate the proposed substation footprint (6.25ha) were then identified within each zone. An example of this process is presented for substation Zone B below (**Plate 4-2** and **Plate 4-3**).

Plate 4-2: Zone B with constraints mapped

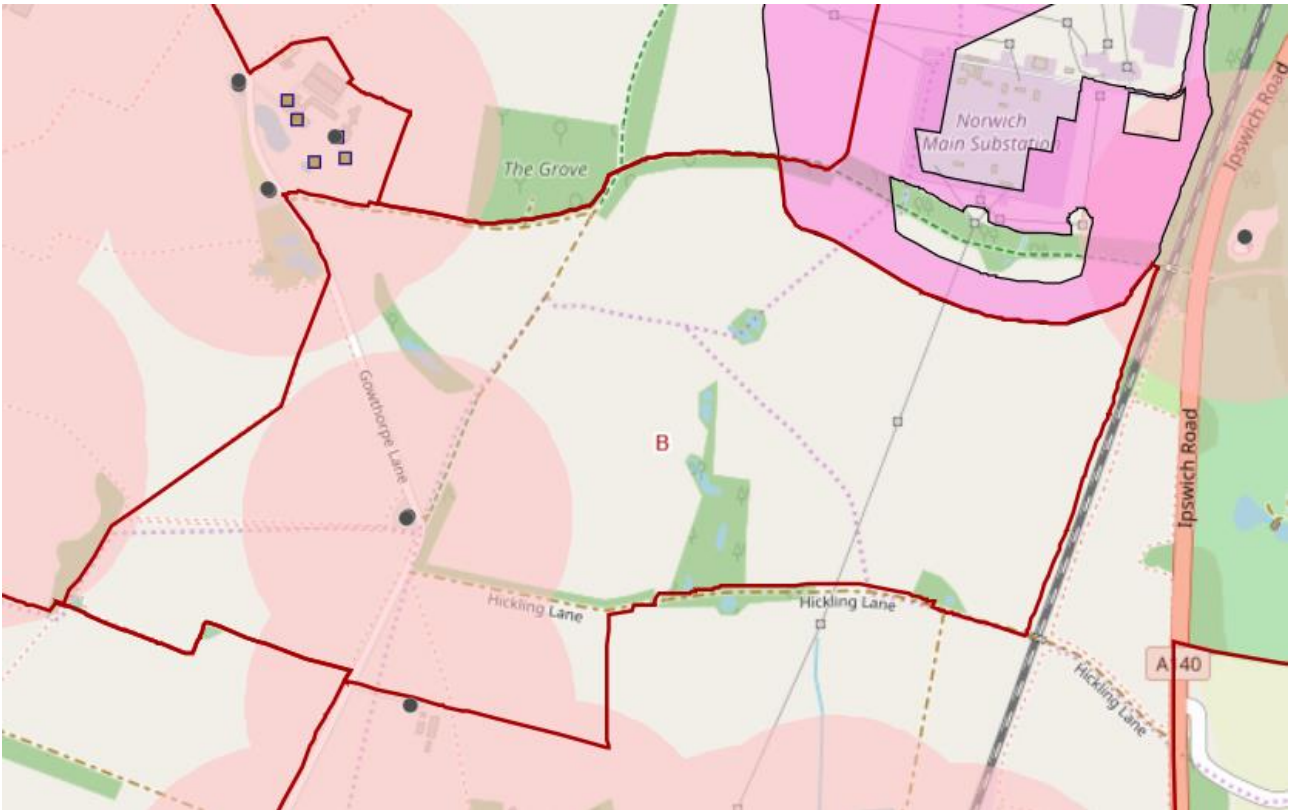
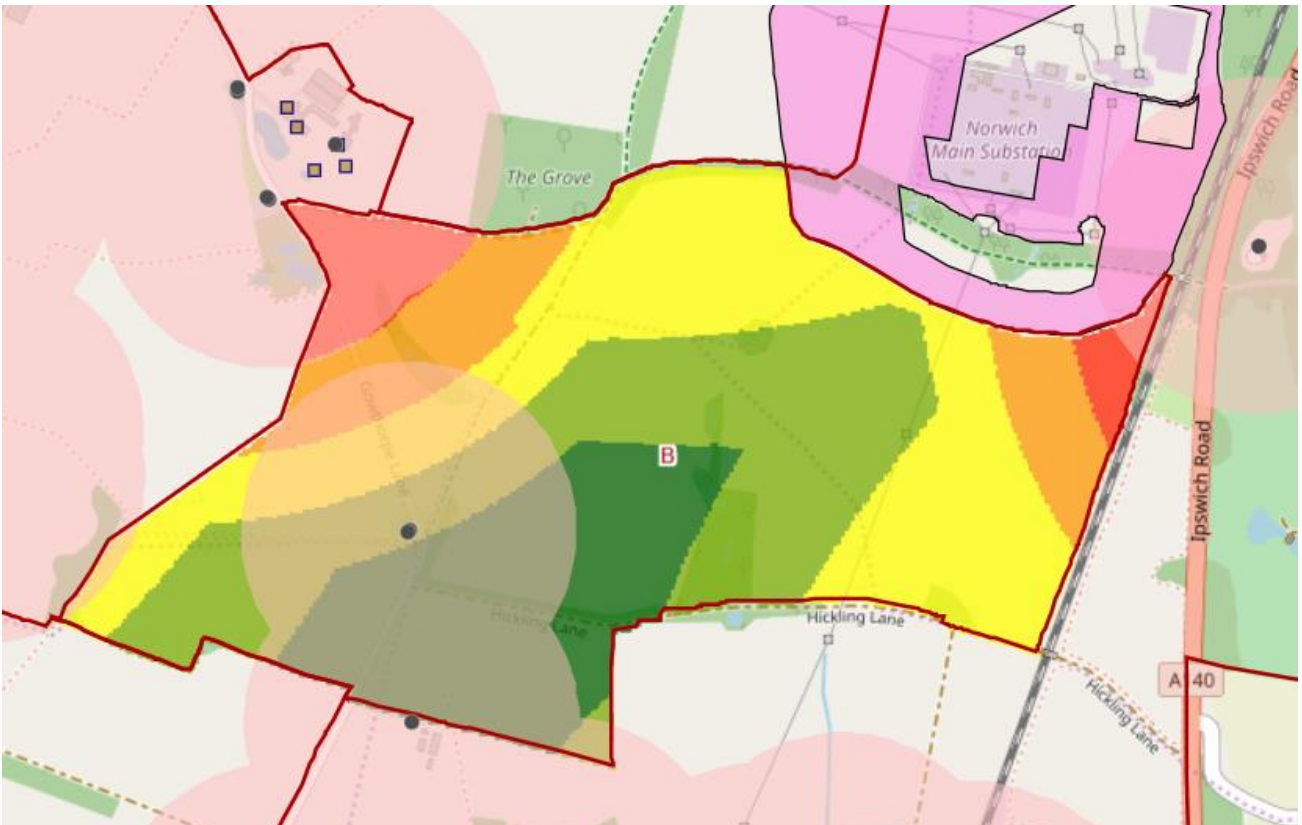
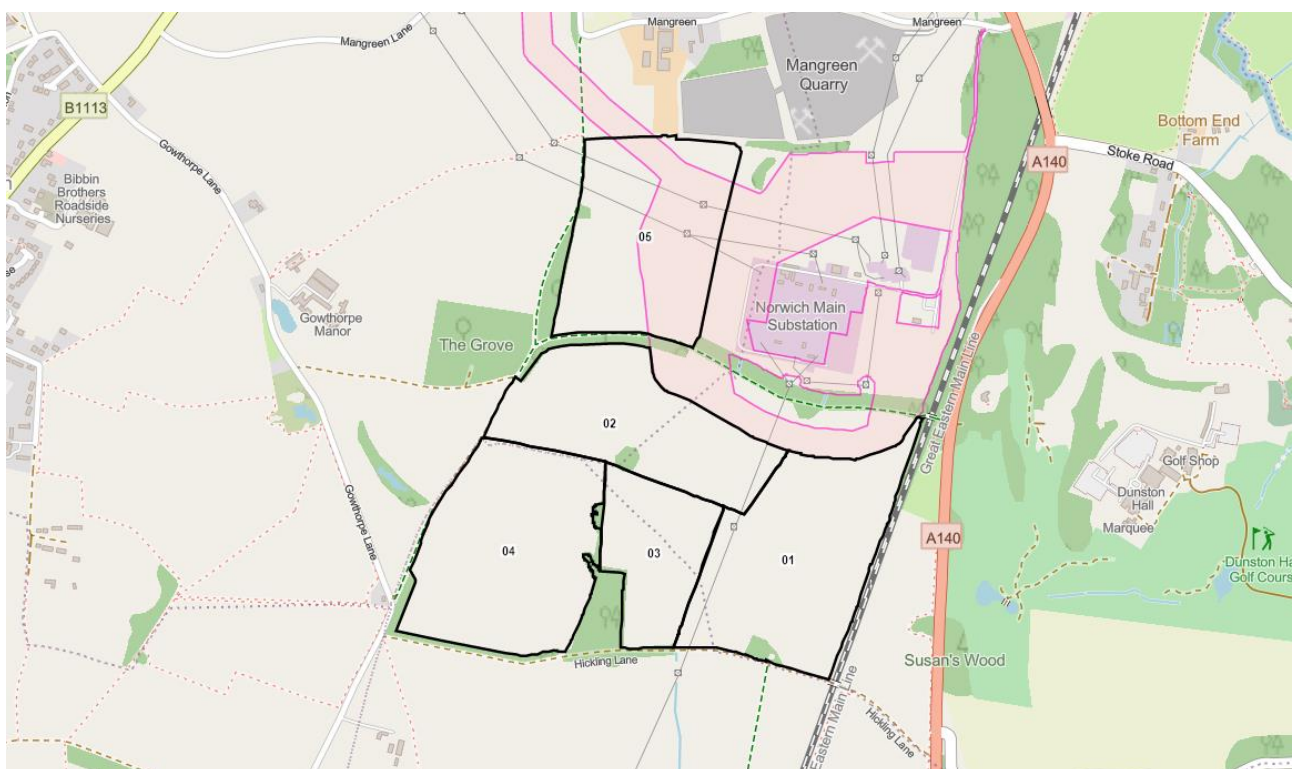


Plate 4-3: Zone B with constraints and combined ranking visually presented - dark green (most preferred) to red (least preferred)



78. This process resulted in the identification of a long-list of 17 fields across the five preferred zones A-E.
79. A Black/Red/Amber/Green (BRAG) assessment was undertaken for the 17 fields to identify the risks and opportunities associated with each field option. Higher risk fields were given a red rating, whilst those with medium risks were coded amber and those with the least risk are assigned green. Black options are those which are not feasible from an engineering or environmental perspective. The aim was to ascertain which fields carry the least risk with respect to the assessment criteria applied and based upon professional judgement.
80. Five of the 17 fields were identified as having the fewest risks primarily based on the distance of separation between them and the nearest residential properties (typically in excess of 400m) and other visual receptors, and the relatively short distance for onward cabling for the 400kV cable connection to Norwich Main. These five fields are identified in **Plate 4-4** below.

Plate 4-4: The five fields identified with the greatest potential to accommodate the proposed substation infrastructure.

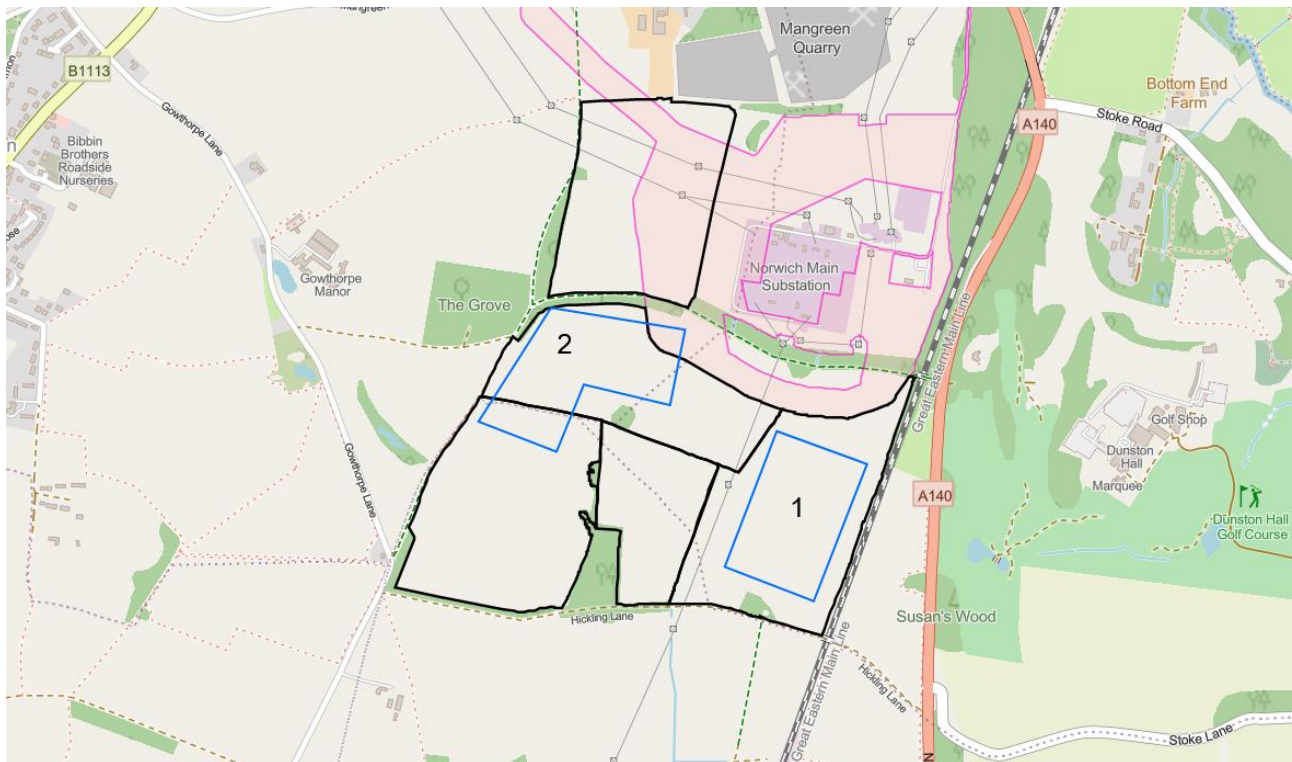


81. The five fields identified were consulted upon during public consultation through a digital engagement consultation website. Phase 1 consultation on site selection for the onshore substation and cable corridor ran from 9th July to 20th August 2020, which included meetings with landowners, stakeholders and regulators.
82. The feedback from local communities is presented in **Table 4-2**.

4.10.3 Identification of PEIR Boundary

83. Further engineering micro-siting and stakeholder engagement work was undertaken in autumn 2020 to identify preferred locations to potentially accommodate the proposed infrastructure within the five fields taken forward. This confirmed that there would be insufficient space to accommodate the proposed infrastructure in Field 5 given the extent of the works footprint associated with Hornsea Project Three OWF, and this field was subsequently discounted. Alongside the engineering feasibility exercise, additional consideration was given to the theoretical visibility from the nearest residential areas. These exercises identified a preference for Field 1 and parts of Fields 2 and 4 to accommodate the proposed substation infrastructure. On this basis two substation site options were identified and form the basis of the assessment work presented in this PEIR. The two substation site options are shown on **Plate 4-5** and **Figure 4.10**.

Plate 4-5: The two substation options (blue boundary) taken forward for assessment within the PEIR.



4.11 Summary

84. The site selection process for DEP and SEP to date has been an iterative one involving the consideration of technical and environmental constraints. For the offshore elements this has involved an initial zone selection undertaken by TCE and further detailed site specific studies conducted by the Applicant. These processes involved consultation with a range of stakeholders and the collation of existing and site specific data in order to refine broad search areas into the current boundaries for the offshore development area.

85. For the onshore infrastructure (i.e. landfall, onshore cable corridor and onshore substation location) the site selection process involved the consideration of technical constraints, environmental effects and deliverability. Each part of the site selection and refinement process has been consulted on to date, and feedback from these consultations has been a key part in determining the PEIR boundary.
86. **Table 4-5** gives an overview of the site selection decisions that have been described in this chapter.

Table 4-5: Summary of key site selection decisions

Infrastructure Element	Options considered	Decision	Main environmental benefits
Landfall	<ul style="list-style-type: none"> • Weybourne; • Bacton; and • Happisburgh. 	Weybourne (west)	<ul style="list-style-type: none"> • Lower elevation at the coastline and other technical advantages; • Shorter route, minimising footprint; • Avoids populated areas at the coast and those at risk of coastal erosion as far as possible; • Avoids the SAC; • Less offshore cable and pipeline crossings; • Better access; and • High confidence in the feasibility of HDD works due to previous installations.
Offshore export cable corridor	Multiple	Export cable corridor to Weybourne (with landfall at Weybourne West)	<ul style="list-style-type: none"> • Shorter route, minimising footprint; • Avoids the SAC; • Less offshore cable and pipeline crossings; • Avoids Bacton sandscaping scheme; and • Avoids area of outcropping chalk further offshore.

Infrastructure Element	Options considered	Decision	Main environmental benefits
Onshore substation	17 sites within 5 zones	Site 1 and 2	Site 1 and 2 are located away from the nearest residential properties and other sensitive receptors. The proximity to the existing Norwich Main substation also minimises the length of buried cabling.
Onshore cable route	<p>The onshore cable corridor proposed was selected based upon guiding design principles and a cable corridor refinement process which included consultation feedback.</p> <p>The route of the onshore cable route is largely determined by the location and configuration of the onshore substations at PEIR stage.</p>		
National Grid connection point	<p>Following the completion of the CION process National Grid made a grid connection offer in April 2019 for connection at Norwich Main National Grid Substation that would accommodate both DEP and SEP. The Applicant accepted this offer in May 2019.</p>		

4.12 References

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