Hornsea Project Four: Environmental Statement (ES)

PINS Document Reference: A4.3.2
APFP Regulation: 5(2)(a)

Volume A4, Annex 3.2: Selection and Refinement of Offshore Infrastructure

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Glossary

Term	Definition
BRAG Assessment	An assessment based on quantitative assessment and expert judgement. The ranking is defined as: • Black: Potential showstopper to development; • Red: High potential to constrain development; • Amber: Intermediate potential to constrain development; and • Green: Low potential to constrain development. Black and red constraints are critical in determining features that should be avoided wherever possible to avoid consenting risk, reduce EIA complexity and reduce the cost of mitigation. Amber and green constraints are those that may be more readily minimised or managed by employing appropriate mitigation measures.
Commitment	A term used interchangeably with mitigation and enhancement measures. The purpose of Commitments is to reduce and/or eliminate Likely Significant Effects (LSEs), in EIA terms. Primary (Design) or Tertiary (Inherent) are both embedded within the assessment at the relevant point in the EIA (e.g. at Scoping, Preliminary Environmental Information Report (PEIR) or ES). Secondary commitments are incorporated to reduce LSE to environmentally acceptable levels following initial assessment i.e. so that residual effects are acceptable.
Design Envelope	A description of the range of possible elements that make up the Hornsea Four design options under consideration, as set out in detail in the project description. This envelope is used to define Hornsea Four for Environmental Impact Assessment (EIA) purposes when the exact engineering parameters are not yet known. This is also often referred to as the "Rochdale Envelope" approach.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for one or more Nationally Significant Infrastructure Projects (NSIP).
Electrical Infrastructure Study Area	The study area between the onshore substation and offshore array area
Export cable corridor (ECC)	The specific corridor of seabed (seaward of Mean High Water Springs (MHWS)) and land (landward of MHWS) from the Hornsea Four array area to the Creyke Beck National Grid substation, within which the export cables will be located.
Export cable corridor (ECC) search area	The broad offshore corridor of seabed (seaward of the MHWS) and land (landward of MHWS) from the Hornsea Project Four array area to the Creyke Beck National Grid substation considered within the Scoping Report, within which the refined ECR corridor will be located.
High Voltage Alternating Current (HVAC)	High voltage alternating current is the bulk transmission of electricity by alternating current (AC), whereby the flow of electric charge periodically reverses direction.

Term	Definition
High Voltage Direct Current (HVDC)	High voltage direct current is the bulk transmission of electricity by direct current (DC), whereby the flow of electric charge is in one direction.
Hornsea Project Four Offshore Wind Farm	The proposed Hornsea Project Four Offshore Wind Farm project. The term covers all elements within the Development Consent Order (i.e. both the offshore and onshore components). Hereafter referred to as Hornsea Four.
HVAC booster station(s)	Offshore HVAC booster station(s) are required in HVAC transmission systems only; they are not required in HVDC transmission systems. If required for Hornsea Four, they would be located entirely offshore.
Interconnector cables	Cables that may be required to interconnect the offshore substations in order to provide redundancy in the case of cable failure elsewhere, or to connect to the offshore accommodation platforms in order to provide power for operation.
Intertidal	The area of the shoreline which is covered at high tide and uncovered at low tide.
Maximum design scenario (MDS)	The maximum design parameters of each Hornsea Four asset (both on and offshore) considered to be a worst case for any given assessment.
Mitigation	A term used interchangeably with Commitment(s) by Hornsea Four. Mitigation measures (Commitments) are embedded within the assessment at the relevant point in the EIA (e.g. at Scoping, PEIR or ES).
Offshore accommodation platform(s)	Used to accommodate multiple O&M staff for a number of weeks at a time and to allow spares and tools to be stored within the array area.
Offshore substation(s)	One or more offshore substations to convert the power to higher voltages and/or to HVDC and transmit this power to shore.
Order Limits	The limits within which Hornsea Project Four (the 'authorised project) may be carried out.
Orsted Hornsea Project Four Ltd	The Applicant for the proposed Hornsea Project Four Offshore Wind Farm Development Consent Order (DCO).
Planning Inspectorate (PINS)	The agency responsible for operating the planning process for Nationally Significant Infrastructure Projects (NSIPs).
Wind turbine	All of the components of a wind turbine, including the tower, nacelle, and rotor.
Wind turbine foundation	The wind turbines are attached to the seabed with a foundation structure typically fabricated from steel or concrete.

Acronyms

Acronym	Definition
AfL	Agreement for Lease
AOD	Above Ordnance Datum
BRAG	Black, Red, Amber, Green (Assessment Criteria)
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
Co*xx*	Commitment (followed by number)
CPA	Closest Point of Approach
DCO	Development Consent Order
ECC	Export Cable Corridor
EIA	Environmental Impact Assessment
EISA	Electrical Infrastructure Study Area
ERYC	East Riding of Yorkshire Council
HDD	Horizontal Directional Drilling
IFCA	(Association of) Inshore Fisheries and Conservation Authorities
MCZ	Marine Conservation Zone
MHW	Mean High Water
MLW	Mean Low Water
MoD	Ministry of Defence
MWLS	Mean Low Water Spring
NSIP	Nationally Significant Infrastructure Project
OFTO	Offshore Transmission Owner
PEIR	Preliminary Environmental Information Report
PINS	Planning Inspectorate
RPSS	Route planning and site selection
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SCI	Site of Community Importance
SMP	Shoreline Management Plan
SPA	Special Protected Area
SSSI	Site of Special Scientific Interest
TCE	The Crown Estate
TJB	Transition Joint Bay
UK	United Kingdom
UXO	Unexploded Ordnance

Units

Unit	Definition
km	Kilometre(s)
m	Metre(s)
m/yr	Metre(s) per year

1 Introduction

1.1 Background

1.1.1 Overview of Hornsea Four Approach

1.1.1.1 Orsted Hornsea Project Four Limited ('the Applicant') is proposing to develop Hornsea Project Four Wind Farm (hereafter 'Hornsea Four'). The route planning and site selection (RPSS) process for Hornsea Four has followed an iterative approach to ensure the most appropriate solution was identified efficiently, with due consideration of environmental, technical and commercial matters. The five key stages are shown in **Table 1**.

Table 1: Hornsea Four Route Planning and Site Selection Stages.

Stage	Associated Document
Stage 1: Identification of the AfL and Grid Connection	Volume A1, Chapter 3: Site selection and consideration of alternatives
Stage 2: Identification of an Electrical Infrastructure Study area	Volume A1, Chapter 3: Site selection and consideration of alternatives
Stage 3: Identification of the Landfall	Volume A4, Annex 3.1: Refinement of the Cable Landfall
Stage 4: Identification of the Onshore Substation (OnSS) site	Volume A4, Annex 3.3: Selection and Refinement of the Onshore Infrastructure
Stage 5: Identification of the Offshore and Onshore Export Cable Corridor (ECC)	Volume A4, Annex 3.2: Selection and Refinement of the Offshore Infrastructure and Volume A4, Annex 3.3: Selection and Refinement of the Onshore Infrastructure

1.1.1.2 The Hornsea Four Electrical Infrastructure Study Area (EISA) is largely defined by the AfL (location of the Hornsea Four array area) and grid connection point at Creyke Beck (location of the OnSS). These two locations formed the eastern and western extents of the Electrical Infrastructure Study Area (EISA). The EISA has been used to structure the RPSS reporting format, with:

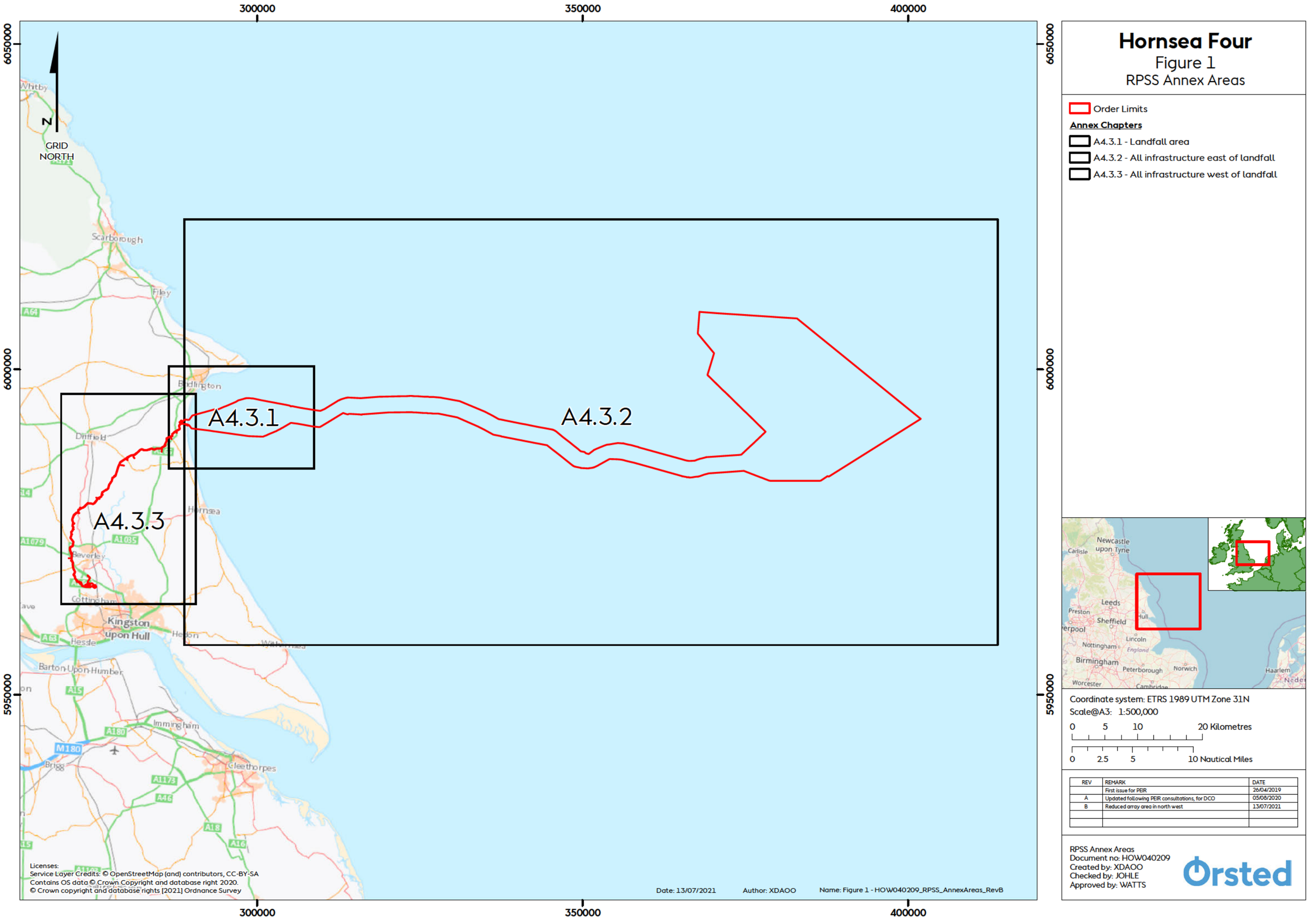
- Landfall covered in **Volume A4, Annex 3.1: Refinement of the Cable Landfall**;
- All Hornsea Four offshore infrastructure east of landfall covered in **Volume A4, Annex 3.2: Selection and Refinement of the Offshore Infrastructure**; and
- All Hornsea Four onshore infrastructure to the west detailed in **Volume A4, Annex 3.3: Selection and Refinement of the Onshore Infrastructure**.

1.1.1.3 This is shown in **Figure 1**.

Hornsea Four

Figure 1

RPSS Annex Areas



Order Limits

Annex Chapters

- A4.3.1 - Landfall area
- A4.3.2 - All infrastructure east of landfall
- A4.3.3 - All infrastructure west of landfall

Coordinate system: ETRS 1989 UTM Zone 31N

Scale@A3: 1:500,000

0 5 10 20 Kilometres

0 2.5 5 10 Nautical Miles

REV	REMARK	DATE
	First issue for PEIR	26/04/2019
A	Updated following PEIR consultations, for DCO	05/08/2020
B	Reduced array area in north west	13/07/2021

RPSS Annex Areas
Document no: HOW040209
Created by: XDAOO
Checked by: JOHLE
Approved by: WATTS

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1.1.2 Hornsea Four Programme and Timeframes

1.1.2.1 The RPSS process has been structured incrementally, with early and frequent stakeholder engagement prioritised, through public consultation, landowner liaison and regular stakeholder correspondence. This is set out in Table 2.

1.1.2.2 The RPSS process specific to offshore infrastructure is shown in Figure 2 and Figure 3.

Table 2: Hornsea Four RPSS Programme.

Stage	Description
EIA Scoping October 2018	• 2,000 m onshore ECC scoping boundary and indicative 200 m permanent ECC and 700 m temporary works area; • OnSS search area; • Landfall search area; and • 3,000 m offshore ECC scoping boundary.
Scoping – Preliminary Environmental Information Report (PEIR) consultation	• Feedback and comments from informal public consultation events, landowner liaison and stakeholders on the scoping report and scoping boundary.
PEIR July 2019	• 80m onshore ECC inclusive of permanent and temporary works areas with indicative construction access points. • Compounds: logistics, Horizontal Directional Drilling (HDD) and/or storage compounds outside of the permanent cable corridor for auxiliary works. • Access: Area required for access (temporary or permanent) to the construction and/or operation and maintenance activities. • OnSS site. • Two landfall options. • 1,500 offshore permanent ECC with 500m temporary works areas buffer either side of ECC).
Section 42 and 47 consultation	• Feedback from stakeholders and members of the public upon receipt of more detailed environmental assessment work will further inform the RPSS process.
DCO Application Q3 2020	• Onshore ECC (80 m) which will contain all permanent (electrical cables and Transition Joint Bays (TJBs)) and temporary works for construction works and soil storage. The details of which will be developed during detailed design; • Compounds: logistics, Horizontal Directional Drilling (HDD) and/or storage compounds outside of the permanent cable corridor for auxiliary works; • Access: Area required for access (temporary or permanent) to the construction and/or operation and maintenance activities; • OnSS: preferred site within the onshore substation search area; • Landfall: preferred site within the landfall search area; and • Offshore ECC (1,500 m): the area within which the export cable route and temporary works area (500 m buffer either side of ECC) are planned to be located.

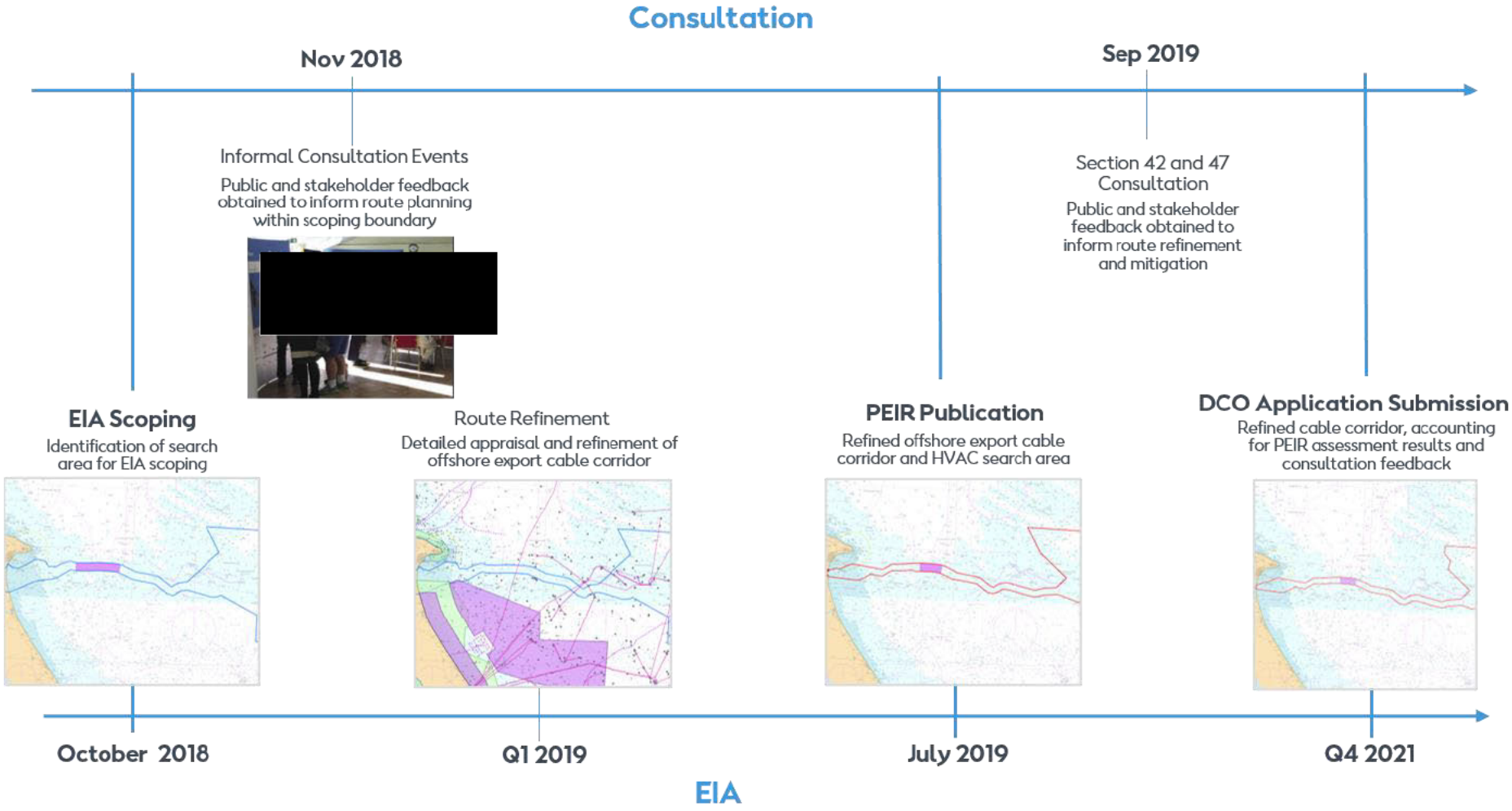


Figure 2: Offshore Export Cable Route Planning and Site Selection Timeline.

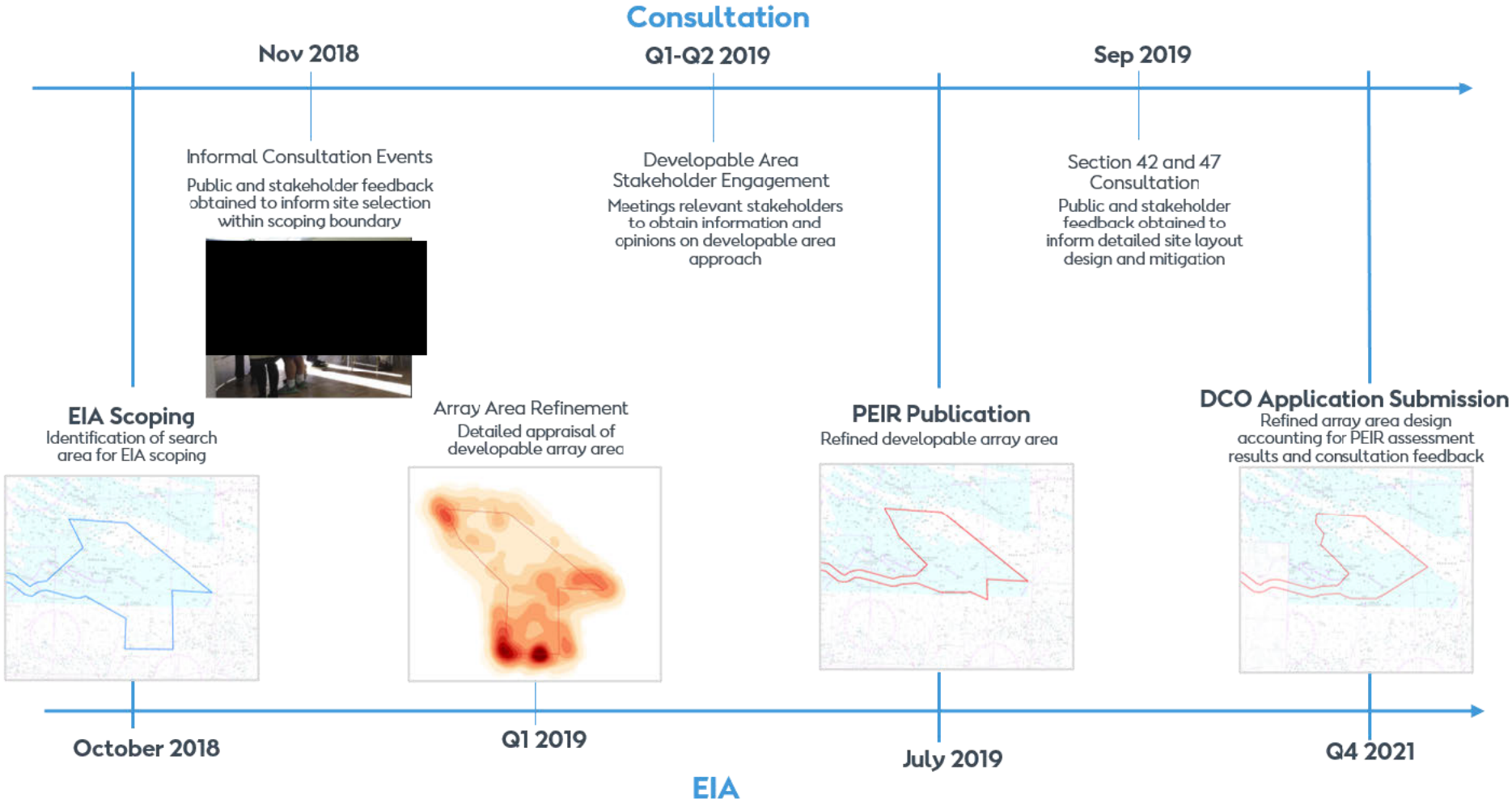


Figure 3: Offshore Array Site Selection Timeline.

1.2 Purpose of the Annex

1.2.1.1 The purpose of this annex is to document the decision making behind the refinement of the offshore infrastructure since identification of the EISA up to submission of the Environmental Statement (ES). The offshore project element comprises all infrastructure seaward of the landfall (as shown in Figure 1). This Annex documents:

- Stage 5 – Identification of the Offshore Export Cable Corridor (ECC).

1.2.1.2 This document is structured so that details relevant to offshore ECC are presented first followed by the array area refinement.

1.2.1.3 Prior to submission of the ES, the Applicant has engaged with a range of stakeholders with regards to the progress of the project and emerging project design matters. Stakeholders that were consulted as part of the ongoing route planning a site selection (RPSS) process, from project inception to ES submission, included:

- The Planning Inspectorate;
- East Riding of Yorkshire Council (ERYC);
- The Environment Agency;
- Marine Management Organisation;
- North Eastern Inshore Fisheries and Conservation Authority (NEIFCA); and
- Natural England;
- Highways Agency;
- The Wildlife Trust;
- Landowners;
- Parish Councils; and
- Members of the public at local information events held in East Riding and surrounds in 2018 and at formal consultation events held in September 2019.

1.3 Project Elements

1.3.1.1 The Hornsea Four offshore electrical transmission system will consist of up to six offshore export cables and up to three offshore booster substations to collect and transport power produced at the wind turbines within the windfarm array to the UK electricity transmission network within a 1.5 km offshore ECC.

2 Offshore ECC Site Selection Methodology

2.1 Guiding Principles

2.1.1.1 Offshore ECC routing is a minimisation exercise to identify the shortest possible route from the offshore Agreement for Lease (AfL) area to the selected landfall site, whilst avoiding constraints dictated by engineering limitations, physical, third-party, environmental and existing seabed users.

2.1.1.2 The aim of the process is to establish indicative preliminary routes for the offshore ECC, through baseline data collection and a staged refinement approach (as described in this Annex) in order to identify a route of sufficient confidence to commission site specific surveys. A preferred 1.5 km offshore ECC was then taken forward through the EIA process, which provides sufficient flexibility within it to enable micro siting refinement following receipt of site-specific survey outputs and stakeholder feedback.

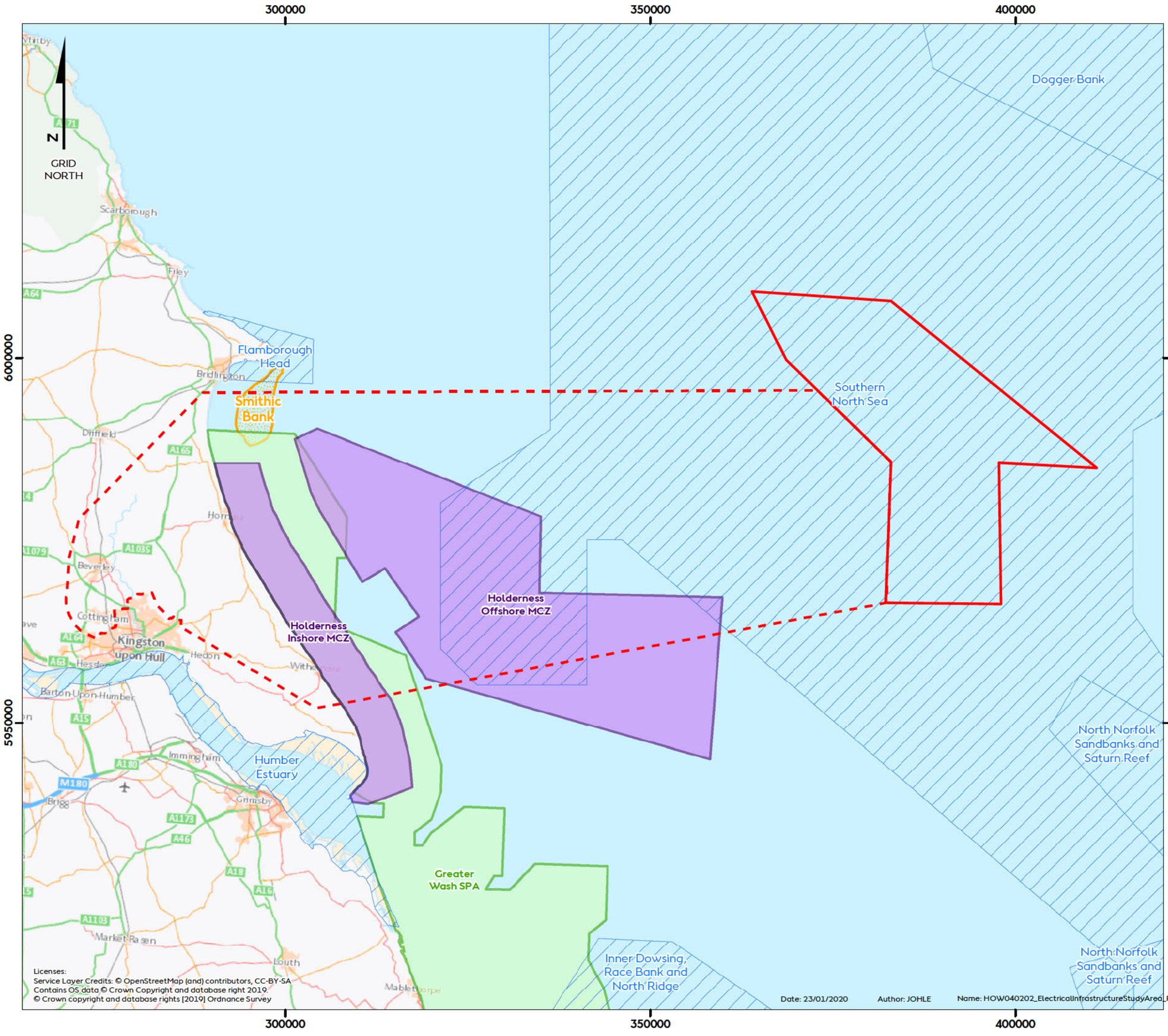
2.1.1.3 The offshore EISA was largely defined by the AfL (location of the wind farm array) and landfall location. These two locations formed the eastern and western extent of the EISA as illustrated in **Figure 4**.

2.1.1.4 The general guiding principles for route planning and site selection of the offshore ECC were to:

- select the shortest route (hence reduce environmental impacts by minimising footprint and electrical transmission losses (most efficient project));
- avoid key sensitive features where possible and where not, seek to mitigate impacts, supported by the following commitments:
  - **Co44**: The Holderness Inshore Marine Conservation Zone (MCZ) will not be crossed by the offshore export cable corridor including the associated temporary works area;
  - **Co45**: The Holderness Offshore Marine Conservation Zone (MCZ) will not be crossed by the offshore export cable corridor including the associated temporary works area;
  - **Co46**: The offshore export cable corridor and the array will be routed to avoid any identified archaeological receptors pre-construction, with buffers as detailed in the Marine Written Scheme of Investigation (WSI);
  - **Co48**: Annex 1 habitats will be avoided where possible, informed through the undertaking of geophysical survey works pre-construction;
  - **Co86**: The offshore export cable corridor and cable landfall (below MHWS) will not cross the Greater Wash SPA, Flamborough & Filey Coast SPA and the Flamborough Head SAC;
  - **Co140**: A Marine Written Scheme of Archaeological Investigation (WSI) will be developed in accordance with the Outline Marine WSI. The Marine WSI will include the requirement for Archaeological Exclusion Zones (AEZs) to be established to protect any known / identified marine archaeological receptors and the implementation of a Protocol for Archaeological Discoveries (PAD) in accordance with 'Protocol for Archaeological Discoveries: Offshore Renewables Projects' (The Crown Estate, 2014).

Hornsea Four

Figure 4
Electrical Infrastructure
Study Area



Date: 23/01/2020 Author: JOHLE Name: HOW040202_ElectricalInfrastructureStudyArea_RevA

- Hornsea Four Array Area (AFL)
- Electrical Infrastructure Study Area
- Special Area of Conservation (SAC)
- Marine Conservation Zone (MCZ)
- Greater Wash Special Protection Area (SPA)
- Smithic Bank

Coordinate system: ETRS 1989 UTM Zone 31N
Scale@A3: 1:500,000

0 5 10 20 Kilometres

0 2.25 4.5 9 Nautical Miles

REV	REMARK	DATE
	First issue for PEIR	16/04/2019
A	Updated for DCO	07/11/2019

Electrical Infrastructure Study Area
Document no: HOW040202
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2.2 Baseline Data & Constraint Mapping

2.2.1.1 Seeking to minimise interaction with physical constraints such as offshore cables and pipelines played a key part in establishing indicative offshore ECC options. These options were then refined, taking account of obstructions such as surface and subsurface infrastructure, aggregate areas and sensitive environmental areas as more information on the site became available.

2.2.1.2 The following considerations were reviewed throughout the site selection process to determine the most appropriate offshore ECC route.

2.2.2 Seabed Bathymetry

2.2.2.1 **Figure 5** summarises the bathymetric features within the EISA. The largest sandwaves observed to the north west of the AfL were considered to pose a potential technical constraint and were avoided wherever possible.

2.2.3 Physical and Infrastructure

2.2.3.1 **Figure 5** provides detail of the existing offshore infrastructure within the EISA.

2.2.3.2 Minimising the level of interference with obstacles and hazards is a key constraint in areas that are highly developed / utilised.

2.2.3.3 Physical constraints such as hard ground conditions, wrecks, excessive slopes, shallow water and deep depressions were avoided through route refinement. Third-party obstacles, linear in nature such as cables and pipelines will be crossed. If the export cables must cross third-party infrastructure, both assets must be protected with rock protection. The number of cable crossings is minimised wherever possible.

2.2.3.4 When approaching an obstacle, the turning radius of the burial tool and installation vessel must be considered. This is critical when approaching an asset that needs crossing in order to reach an optimal crossing angle of 90 degrees, allowing for sufficient linear distance for the cable to ride out prior to the crossing itself and to bed back in afterwards.

2.2.3.5 There are also other third-party features which, although they can be crossed, should be avoided to minimise risk to the cable – these include, but are not restricted to, anchorage areas and navigation aids. Areas exploited by human activity that could increase both the risk to the cable during operation and be a source of conflict during installation were considered and avoided in route development. In certain instances, such as shipping routes and fishing grounds, total avoidance is not possible, and conflict can be mitigated. **Table 33** presents the physical and third-party constraints considered along with a preference of mitigation.

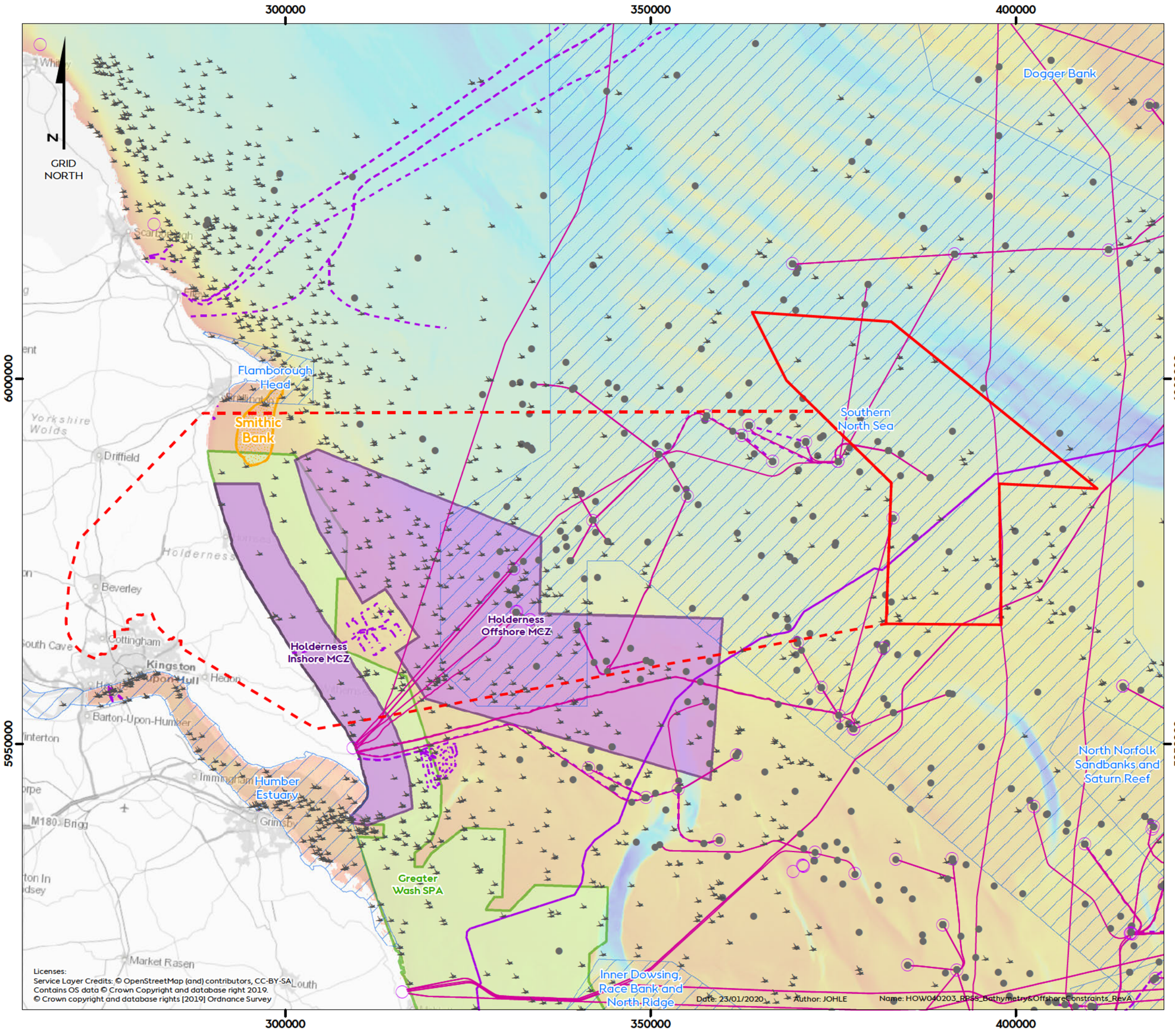
Table 3: Physical & Third-Party Constraints.

Constraint	Preference	Mitigation
UXO	Avoid	Survey, re-route, clearance
Military PEXA	Avoid	Re-route
Dredging Areas	Avoid	Re-route
Munitions Dumping Grounds	Avoid	Re-route
Wrecks	Avoid	Re-route
Navigation Aids	Avoid	Re-route
Boulders	Avoid	Survey, re-route, clearance
Cable Crossings	Avoid, minimise	Re-route, crossing agreements
Cables in Proximity	Avoid, minimise	Re-route, proximity agreements
Pipeline Crossings	Avoid, minimise	Re-route, crossing agreements
Pipelines in Proximity	Avoid, minimise	Re-route, proximity agreements
Offshore Infrastructure	Avoid, maintain distance	Re-route, proximity agreements
Shallow Water	Avoid	Re-route, vessel selection
Seabed Depressions	Avoid	Re-route, installation tool selection
Seabed Mobility	Avoid	Re-route, installation tool selection
Seabed Sandwaves	Avoid	Re-route, installation tool selection
Seabed Slopes	Avoid	Re-route, installation tool selection
Ground Conditions (Soft)	Manageable	Correct cable burial tool selection, reduced burial
Ground Conditions (Hard)	Manageable	Correct cable burial tool selection, reduced burial
Dumping Grounds	Avoid	Re-route, dredging
Foul Grounds	Avoid	Re-route, ground investigation
Anchorage Areas	Avoid	Re-route, deeper burial, move anchorage
Commercial Fishing Grounds	Minimise	Stakeholder engagement
Planned Developments	Manageable	Stakeholder engagement
Traffic Separation Systems	Manageable	Stakeholder engagement
Shipping Routes	Manageable	Stakeholder engagement

Hornsea Four

Figure 5

Seabed Bathymetry and Offshore Constraints

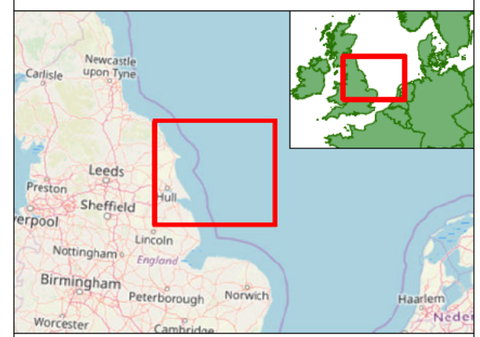


- Hornsea Four Array Area (AFL)
- Electrical Infrastructure Study Area
- Wreck
- Surface Infrastructure
- Well
- Pipeline
- Cable
- Special Area of Conservation (SAC)
- Marine Conservation Zone (MCZ)
- Greater Wash Special Protection Area (SPA)
- Smithic Bank

Bathymetry (mAMSL)

High : 4.6

Low : -96.93



Coordinate system: ETRS 1989 UTM Zone 31N

Scale@A3: 1:500,000

0 5 10 20 Kilometres

0 2.5 5 10 Nautical Miles

REV	REMARK	DATE
	First issue for PEIR	14/06/2019
A	Updated for DCO	07/11/2019

Seabed Bathymetry and Offshore Constraints
Document no: HOW040203
Created by: XDAOO
Checked by: JOHLE
Approved by: DAVKI

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2.2.4 Environmental

2.2.4.1 There were a range of European and nationally protected sites within the EISA. Engineering solutions can in some cases mitigate or minimise impacts upon environmentally sensitive areas.

2.2.4.2 Whilst nature conservation designations were not viewed as a defining factor in the early stages of offshore ECC route selection, as discussed later within this Annex, attempts were made to avoid designated sites of nature conservation i.e. marine conservation zones (MCZ), special areas of conservation (SAC) and special protection areas (SPA).

2.2.4.3 Table 4 presents the environmental constraints considered along with a preference of mitigation.

Table 4: Environmental Constraints.

Constraint	Preference	Mitigation
Designated sites for nature conservation (MCZ, SAC, SPA)	Avoid	Re-route, mitigate through design and micro siting. See Co44, Co45 and Co86 in Volume A4, Annex 5.2: Commitments Register.
Habitats of principal importance (Section 41 of the 2006 Natural Environment and Rural Communities (NERC) Act)	Avoid if possible where alternative location exists.	Mitigate through design and micro siting where possible. See Co48 in Volume A4, Annex 5.2: Commitments Register.
Fish spawning grounds	Avoid if possible where alternative location exists.	Re-route, mitigate through design

3 Initial Selection of Offshore ECC Study Area

3.1 Considerations

3.1.1.1 A number of fundamental principles were applied to the decision-making process throughout offshore ECC route planning:

- Shortest offshore ECC route is preferred. This minimises impacts my reducing the footprint whilst lowering costs (reducing the cost of energy to the consumer) and reducing electrical transmission losses;
- Avoidance of designated sites for nature conservation;
- Avoidance where possible of habitats of principal importance (Section 41 of the 2006 Natural Environment and Rural Communities (NERC) Act), seeking to mitigate through design and micro-siting where possible;
- Minimise the disruption to populated areas; and
- The need to accommodate the range of technology sought within the design envelope and exclude those options out with the envelope.

3.1.1.2 From an environmental perspective **Figure 5** highlights the constrained nature of the EISA. The Greater Wash Special Protection Area (SPA), Holderness Inshore and Offshore Marine Conservation Zones (MCZ) all occupy large areas between the array area and landfall. Preference was given to reducing overlap with all designated sites for nature conservation wherever possible. This approach was supported by statutory consultees at formal Scoping of the project.

3.2 Description

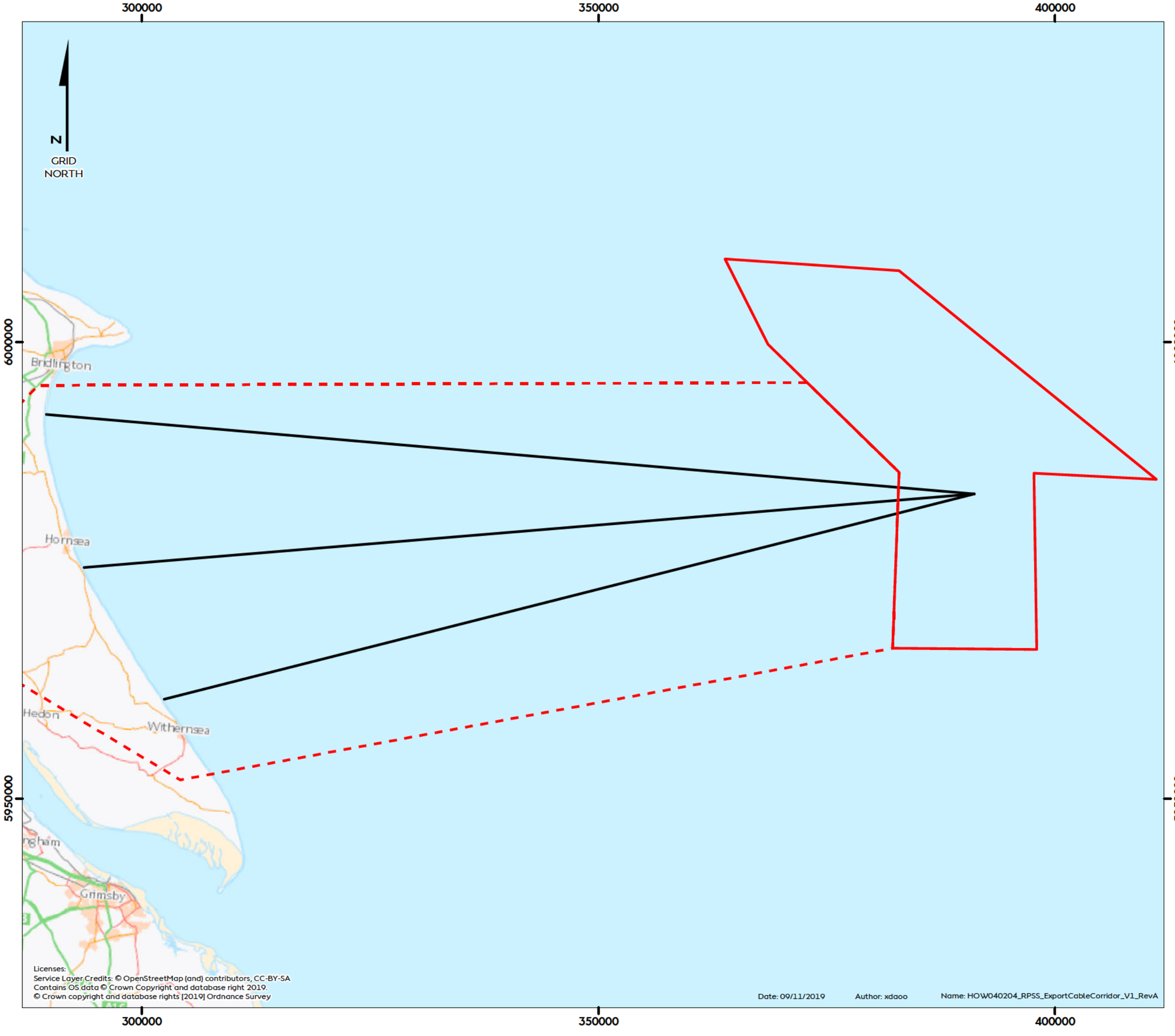
3.2.1 Version 1 - Offshore ECC

3.2.1.1 The process of limiting route length, minimising crossing of cables / pipelines and avoiding obstacles principally enabled the development of three offshore ECC options. Version 1 offshore ECCs were developed as straight-line options, routeing west from the array area to three landfall zones (see **Figure 6**).

Hornsea Four

Figure 6

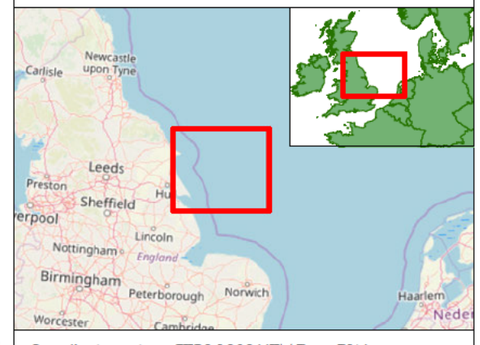
Offshore Export Cable Corridor Version 1



Hornsea Four Array Area (AFL)

Electrical Infrastructure Study Area

Export Cables Version 1



Coordinate system: ETRS 1989 UTM Zone 31N

Scale@A3: 1:400,000

0 4.75 9.5 19 Kilometres

0 2.5 5 10 Nautical Miles

REV	REMARK	DATE
	First issue for PEIR	18/04/2019
A	Updated for DCO	07/11/2019

Offshore Export Cable Corridor Version 1
Document no: HOW040204
Created by: XDAOO
Checked by: JOHLE
Approved by: DAVKI

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4 Refinement of Offshore ECC

4.1 Considerations

4.1.1.1 A number of potential offshore ECC options were developed through a detailed engineering review, utilising the following principles:

- Avoiding physical obstructions wherever possible;
- Minimising the number of cable turn points in the corridor;
- Crossing existing cables and pipelines at 90-degree angles;
- Avoiding conflicting seabed users (e.g. oil and gas infrastructure, aggregate extraction areas);
- Avoiding designated sites for nature conservation; and
- Applying appropriate buffers when routeing in close proximity or parallel to existing infrastructure (see Table 5).

Table 5: Route Refinement Buffer Distances.

Asset Type	Status	Buffer Distance
Subsea cables	Active/Proposed	250 m
	Inactive	100 m
Subsea pipelines	Active/Proposed	500 m
	Inactive	250 m
Historic wrecks	Unprotected	50 m
	Protected	500 m
Oil and gas platforms	Active	500 m
	Inactive	500 m
Oil and gas wellheads	All	100 m
Designated sites for nature conservation	Designated	2 km
Navigational aids	Not applicable	1 km
Designated shipping lanes	Not applicable	100 m
Designated recreational areas	Not applicable	100 m
Designated anchorages	Not applicable	100 m

4.2 Route Development

4.2.1.1 Building upon offshore ECC Version 1, Figure 7–Figure 9 present an overview of the offshore ECC options (Versions 2–4) developed in order to establish a Scoping boundary (ECC Version 5), a PEIR boundary (ECC Version 6) and finally the ES boundary (ECC Version 7).

4.2.1.2 Each offshore ECC option considered alternative ways of routing between the array and landfall sites, limiting interaction with constraints and limiting deviations. Where multiple options were identified, the shortest route was selected. Where uncertainty existed in relation to the optimum route, both options were considered. Refer to Table 10 which

describes the alter-courses undertaken throughout the offshore ECC route refinement process as referenced in **Figure 7**.

4.2.2 Version 2 - Offshore ECC

Refinement

4.2.2.1 Three offshore ECC options were subject to engineering review and route optimisation (see **Figure 7**), aimed at satisfying the selection criteria i.e. minimising cable length, avoiding hard constraints and minimising overlap with existing seabed users.

Justification

4.2.2.2 The rationale for modifications to the offshore ECCs is summarised as follows:

- Maintaining a perpendicular exit from landfall to the 15 m water depth contour;
- Avoiding physical constraints e.g. anchorages, dredging areas, dumping areas, wrecks, infrastructure, cables/pipelines, known rocky ground and shallow sandbanks; and
- Ensuring perpendicular crossings with existing and planned pipelines and cables.

Technical Review

4.2.2.3 **Table 6** provides a high-level comparison between each of the three offshore ECC options at Version 2, differentiating those defining factors in route preference (and therefore landfall zone selection).

Table 6: Version 2 Offshore ECC Appraisal.

Offshore ECC Option	Defining Factors	
	Physical Constraints	*Environmental Constraints*
Northern	- Length: 99 km; - Crosses six pipelines and no cables; - Within 3500 m of a surface infrastructure point; - Within 250 m of three wrecks; - Within 1100 m of a well; and - Overlaps with Dogger Bank Creyke Beck Offshore Windfarm ECC.	None.
Middle	- Length: 98 km; - Crosses five pipelines and no cables; - Within 3500 m of a surface infrastructure point; - Within 250 m of two wrecks; - Within 120 m of a well; and - Overlaps with Dogger Bank Creyke Beck Offshore Windfarm ECC.	Conflicts with The Greater Wash SPA, Holderness Inshore and Holderness Offshore MCZs.

Offshore ECC Option	Defining Factors	
	Physical Constraints	*Environmental Constraints*
Southern	- Length: 89 km; - Crosses six pipelines and no cables; - Within 1400 m of a surface infrastructure point; - Within 250 m of 1 wreck; - Within 150 m of a well; and - Overlaps with Dogger Bank Creyke Beck Offshore Windfarm ECC.	Conflicts with The Greater Wash SPA, Holderness Inshore and Holderness Offshore MCZs.

Environmental Review

4.2.2.4 The following environmental constraints were considered:

- Avoidance of designated sites for nature conservation;
- Avoidance where possible of habitats of principal importance (Section 41 of the 2006 Natural Environment and Rural Communities (NERC) Act); and
- Avoidance of known fish spawning grounds.

4.2.2.5 Routing to either the middle or southern offshore ECC route options results in interaction with a number of designated sites for nature conservation. Interaction with designated sites is eliminated through routing to the northern most offshore ECC route option.

Commercial Review

4.2.2.6 The following commercial constraints were considered:

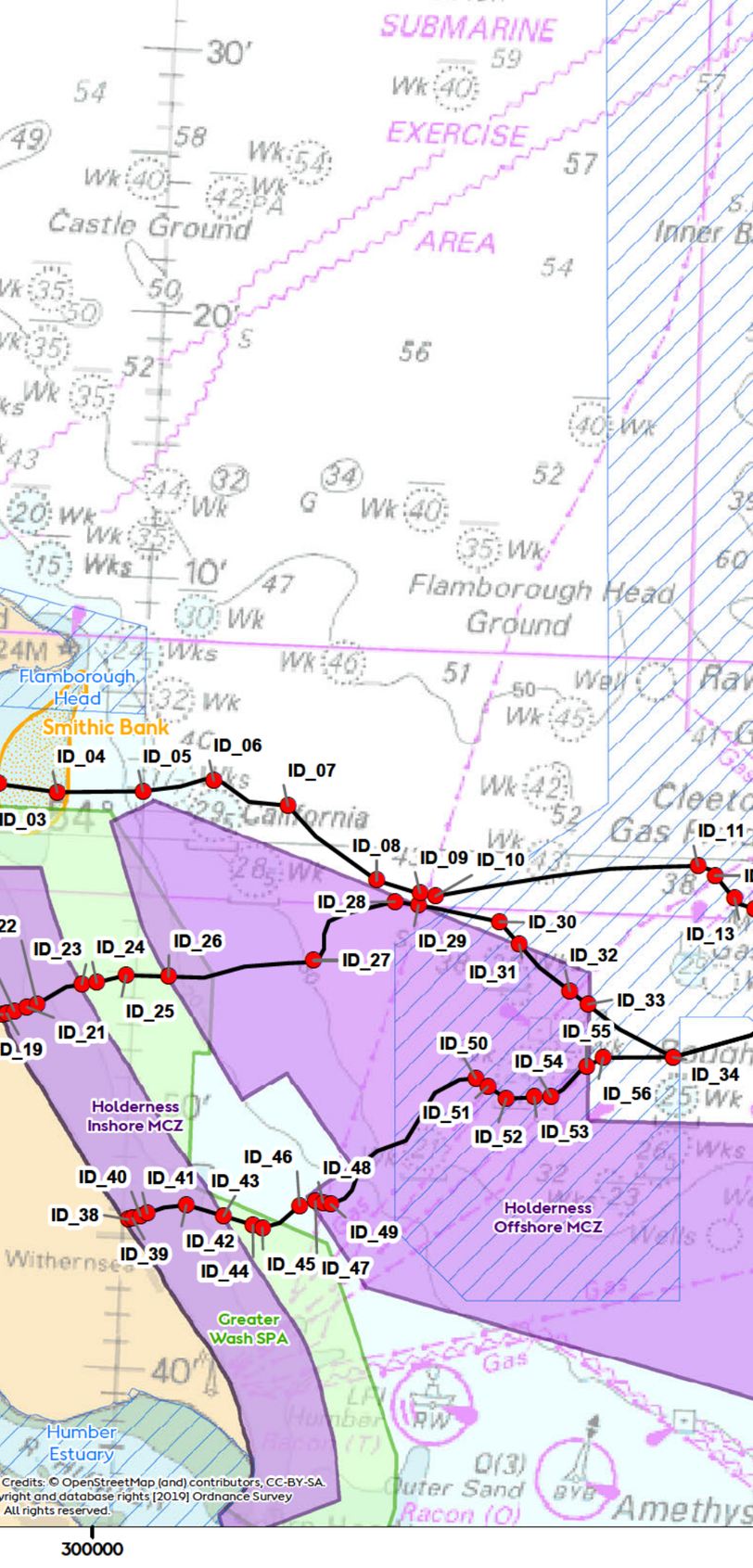
- Avoidance of military firing ranges;
- Avoidance of foul ground areas;
- Alignment with existing cable and pipeline crossings;
- Avoidance of existing windfarm infrastructure; and
- Avoidance of existing oil and gas infrastructure.

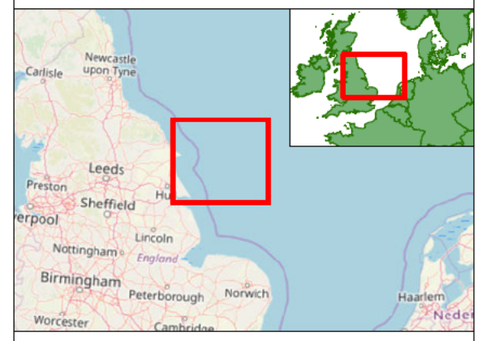
Hornsea Four

Figure 7

Offshore Export Cable Corridor Version 2

- Hornsea Four Array Area (AFL)
- Change
- Export Cables Version
- Special Area of Conservation (SAC)
- Marine Conservation Zone (MCZ)
- Greater Wash Special Protection Area (SPA)
- Smithic Bank





Coordinate system: ETRS 1989 UTM Zone 31N

Scale@A3: 1:400,000

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0 2.5 5 10 Nautical Miles

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Date: 23/01/2020 Author: JOHLE Name: HOW040205_RPS5_ExportCableCorridor_V2_RevA

4.2.3 ECC Version 3

Refinement

4.2.3.1 The Version 2 appraisal supported the northern offshore ECC option, avoiding conflict with designated sites for nature conservation i.e. The Greater Wash SPA, Holderness Inshore and Holderness Offshore MCZs. The project commitment to avoid designated sites for nature conservation was supported by statutory consultees at formal Scoping of the project and subsequently secured by project commitments (see **Volume A4, Annex 5.2: Commitments Register**).

4.2.3.2 These commitments enabled the reduction in the number of landfall options from 23 to seven, all within the northernmost landfall zones A and B. Two alternative routes, to the northernmost landfalls were developed in order to avoid the MCZs.

4.2.3.3 Additional modifications were made offshore, to promote best possible crossing angles of existing seabed infrastructure and avoiding known wrecks as more historic environment data became available.

Justification

4.2.3.4 The Hornsea Four commitment to avoid designated sites for nature conservation meant the southernmost options were dropped from further consideration. It was therefore not possible to avoid the sandbank feature Smithic Bank. This will be mitigated through design, as described in **Table 4** and **Volume A4, Annex 5.2: Commitments Register**.

4.2.3.5 Refer to **Table 10** which describes the alter-courses undertaken throughout the offshore ECC route refinement process and referenced in **Figure 8**.

Technical Review

4.2.3.6 Advised on preference to refine offshore cable and pipeline crossings to 90 degrees where possible.

Environmental Review

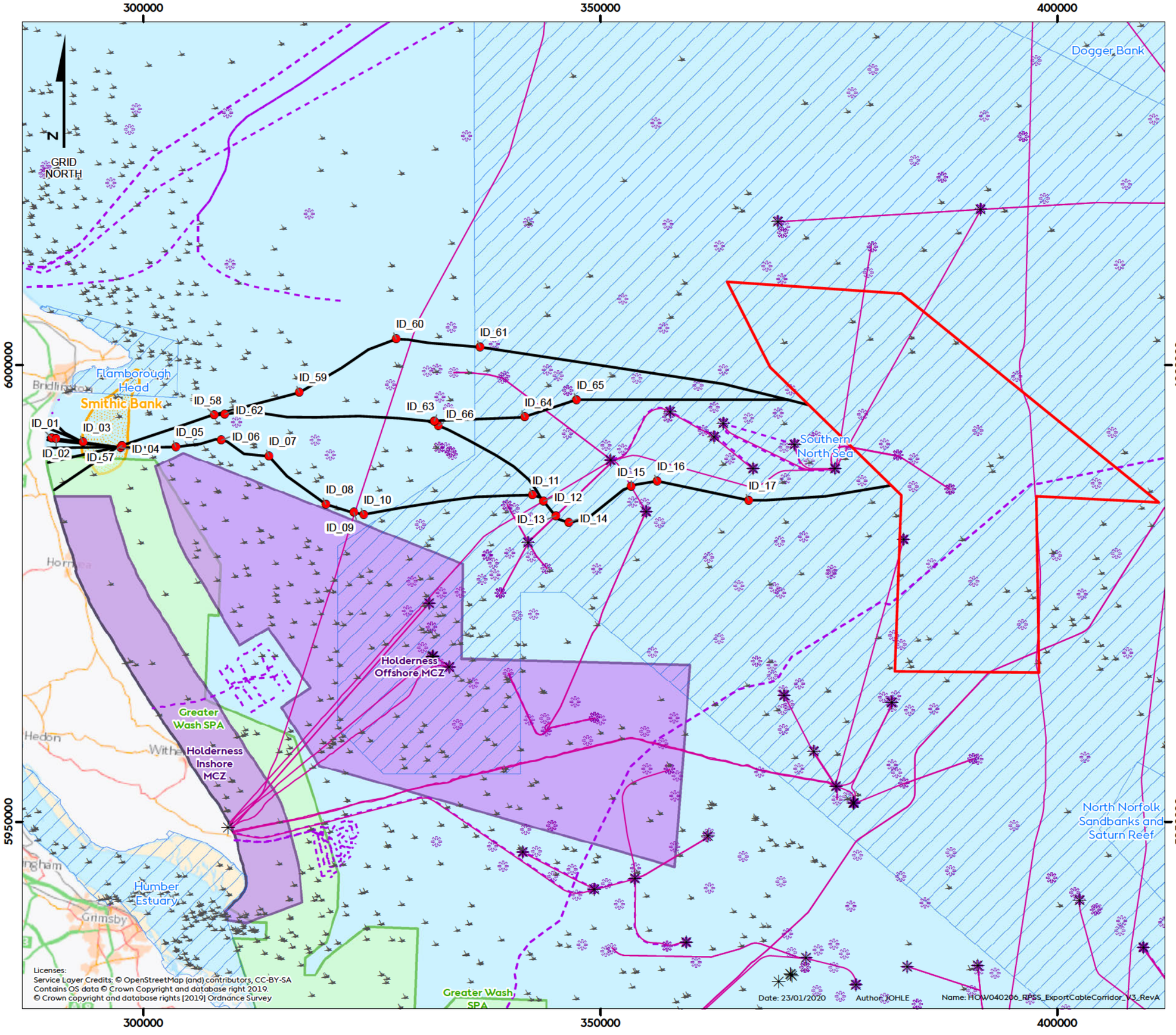
4.2.3.7 Advised on commitment to avoid routing through nature conservation designations and route around all known wreck sites.

Commercial Review

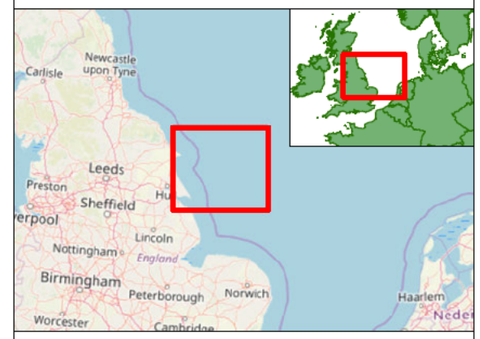
4.2.3.8 No significant constraints identified at this stage.

Hornsea Four

Figure 8
Offshore Export Cable Corridor Version 3



- Hornsea Four Array Area (AFL)
- Export Cables Version 3
- Surface Infrastructure
- Well
- Pipeline
- Cable
- Change Comment
- Special Area of Conservation (SAC)
- Marine Conservation Zone (MCZ)
- Greater Wash Special Protection Area (SPA)
- Smithic Bank



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Scale@A3: 1:400,000

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0 2.5 5 10 Nautical Miles

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4.2.4 Version 4 – Offshore ECC

Refinement

4.2.4.1 Four potential offshore ECCs were assessed against the refinement criteria and Routes 1 to 4 were subsequently modified, as illustrated in **Figure 9**.

Justification

4.2.4.2 The buffer distance around the MCZs was increased, whilst simultaneously avoiding areas of hard substrate to the north of Route 1 and providing alternative crossing options for the existing offshore pipelines and cables. The precise route of the Dogger Bank Offshore Windfarm export cable was unknown, which increased the length of the required crossing.

4.2.4.3 In order to maintain the commitment to avoid all designated sites for nature conservation it was not possible to avoid the sandbank feature Smithic Bank but this will be mitigated through design, as described in **Table 4** and **Volume A4, Annex 5.2: Commitments Register**.

4.2.4.4 Refer to **Table 10** which describes the alter-courses undertaken throughout the offshore ECC route refinement process and referenced in **Figure 9**.

4.2.4.5 Version 4 offshore ECC route options were categorised as follows:

- Route 1: The northernmost route, avoids all major offshore infrastructure crossings and is 94 km in length. Sandwaves identified in the northern portion and some areas of hard substrate identified from BGS data. Sandbank feature (Smithic Bank) located in the nearshore area. One pipeline crossing identified.
- Route 2: Diverges from Route 1 adjacent to the array area, taking a more southerly route before re-joining route 1 approximately 20 km from landfall. 93 km in length. Sandbank feature (Smithic Bank) located in the nearshore area. Two pipeline crossings identified.
- Route 3: Routes south nearing increased oil and gas infrastructure and joining Route 2 approximately halfway along its 95 km length. Four asset crossings were identified coincidental with sandwaves. Sandbank feature (Smithic Bank) located in the nearshore area.
- Route 4: Follows Route 3 for the first half, before diverging south to the southernmost landfall zones. 95 km in length and four asset crossings identified. Sandbank feature (Smithic Bank) located in the nearshore area, routes within 500 m of the Holderness Offshore MCZ boundary and intersects The Greater Wash SPA.

Technical Review

4.2.4.6 Significant sandwaves were identified in proximity to Route 1, potentially making cable installation challenging. Technical advised a preference to avoid major sandwaves and hard substrates to the north of Route 1.

Environmental Review

4.2.4.7 Concern with Route 4 owing to proximity to MCZ boundary and interaction with The Greater Wash SPA. Advised preference to divert Route 4 north increasing buffer distance from the MCZ boundary.

4.2.4.8 Routes 1 to 4 would not avoid the sandbank feature Smithic Bank. This this will be mitigated through design, as described in **Table 4** and **Volume A4, Annex 5.2: Commitments Register**.

Commercial Review

4.2.4.9 No significant constraints identified at this stage.

Route 1: The northernmost route, avoids all major offshore infrastructure crossings and is 94 km in length. Sandwaves identified in the northern portion and some areas of hard substrate identified from BGS data. Sandbank feature (Smithic Bank) located in the nearshore area. One pipeline crossing identified.

Route 2: Diverges from Route 1 adjacent to the array area, taking a more southerly route before re-joining route 1 approximately 20 km from landfall. 93 km in length. Sandbank feature (Smithic Bank) located in the nearshore area. Two pipeline crossings identified.

Route 3: Routes south nearing increased oil and gas infrastructure and joining Route 2 approximately halfway along its 95 km length. Four asset crossings were identified coincidental with sandwaves. Sandbank feature (Smithic Bank) located in the nearshore area.

Route 4: Follows Route 3 for the first half, before diverging south to the southernmost landfall zones. 95 km in length and four asset crossings identified. Sandbank feature (Smithic Bank) located in the nearshore area, routes within 500 m of the Holderness Offshore MCZ boundary and intersects The Greater Wash SPA."

300000 350000 400000

6000000

5950000

N GRID NORTH

Route 1 Route 2 Route 3 Route 4

ID_76 ID_75 ID_74 ID_73 ID_72 ID_71 ID_70 ID_69 ID_68 ID_67 ID_06 ID_07 ID_80 ID_81 ID_63 ID_66 ID_64 ID_65 ID_77 ID_78 ID_15 ID_16 ID_17 ID_11 ID_12 ID_13 ID_14 ID_79

Flamborough Head

Bridlington

Smithic Bank

Southern North Sea

Holderness Offshore MCZ

Holderness Inshore MCZ

Greater Wash SPA

Humber Estuary

North Norfolk Sandbanks and Saturn Reef

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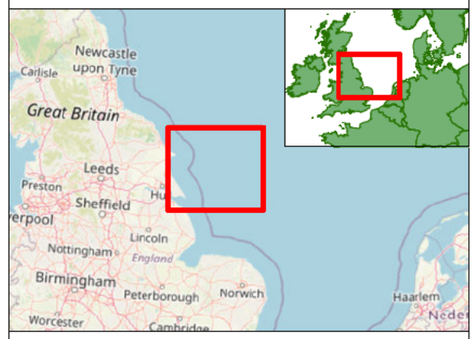
Date: 06/08/2021 Author: XDAOO Name: HOW040207_RPSS_ExportCableCorridor_V4_RevA

Hornsea Four

Figure 9
Offshore Export Cable Corridor Version 4

- Hornsea Four Array Area (AFL)
- Surface Infrastructure
- Well
- Pipeline
- Cable
- Export Cables Version 4
- Dogger Bank Creyke Beck A & B Export Cable (TCE)
- Change Comment
- Special Area of Conservation (SAC)
- Marine Conservation Zone (MCZ)
- Greater Wash Special Protection Area (SPA)
- Smithic Bank



Coordinate system: ETRS 1989 UTM Zone 31N
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0 2.5 5 10 Nautical Miles

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4.2.5 ECC Version 5

Refinement

4.2.5.1 An assessment on Version 4 (see **Figure 9)** involved rating each offshore ECC option against a Black, Red, Amber and Green (BRAG) criteria as defined in **Table 7**. At Scoping Route 3 with two landfall options was identified as the preferred offshore ECC option and formed the basis of offshore ECC Version 5 (see **Figure 10**).

Table 7: BRAG Rating.

Rating	Summary
Black	Potential showstopper to development
Red	High potential to constrain development
Amber	Intermediate potential to constrain development
Green	Low potential to constrain development

4.2.5.2 Black and red constraints were critical in determining features to be avoided wherever possible in order to avoid consenting risk, reduce EIA complexity and reduce the cost of mitigation. Amber and green constraints were those which may be more readily minimised or managed by employing appropriate mitigation measures.

4.2.5.3 The BRAG criteria as defined in **Table 7** assisted in the identification of key technical, consenting and commercial risks areas. Based on the BRAG appraisal, a detailed analysis was undertaken to reduce the number of offshore ECC options from four to one, presented as Version 5 and shown in **Figure 10**. The BRAG criteria was developed by the Applicant based on experience, with the definitions applied to black, red, amber and green applied consistently for both offshore and onshore infrastructure.

4.2.5.4 A buffer was applied to offshore ECC Version 5, in order to create a Scoping Boundary of 3 km wide. This area provided a corridor within which there was a high degree of confidence that a viable ECC could be identified. It also contained sufficient limits of deviation to enable an iterative process (based on stakeholder feedback, further data acquisition and initial engineering optimisation work) for the evaluation of specific routes and infrastructure locations as Hornsea Four progresses through the pre-application phase.

4.2.5.5 The Scoping search area presented as offshore ECC Version 5 is shown in **Figure 10**.

Justification

4.2.5.6 The BRAG assessment criteria are provided in **Table 8** and appraisal in **Table 9**.

4.2.5.7 In summary, Route 3 of Version 4 was selected as the preferred option at Scoping based on the below:

- Least interaction with sandwave features, meaning the lowest installation risk;
- Relatively low number of seabed obstructions;
- No interaction with designated sites for nature conservation;
- No interaction with known carbon capture and storage (CCS) sites; and
- Not the highest commercial fisheries total landings.

4.2.5.8 The project was satisfied all reasonably foreseeable project options could be accommodated in the selected Scoping boundary, based on all known technical, commercial and environmental criteria at that time.

4.2.5.9 Route 3 was consulted on in September 2018 (as part of the Statement of Community Consultation (SoCC)), and between October and November 2018 (Phase 1.A consultation with the public and formal Scoping of the project).

Technical Review

4.2.5.10 BRAG assessment – see **Table 9**.

Environmental Review

4.2.5.11 BRAG assessment – see **Table 9**.

Commercial Review

4.2.5.12 BRAG assessment – see **Table 9**.

Table 8: Offshore Export Cable Corridor Constraints Appraisal Criteria.

Type of Constraint	Category	Black	Red	Amber	Green
Technical	Cable Length	-	Longest	-	Shortest
	Geology	None	Hard strata.	Areas of very soft Holocene material and/or significant gravelly material.	Anything else
	Bathymetry	None	Water depth <10 m	water depth <15 m	water depth ≥15 m
	Seabed Features	≥10 km of sandwave fields and/or ≥8 sandwave interactions.	Between 5–10 km of sandwave fields and/or ≤8 sandwave interactions.	Up to 5 km of sandwave fields and/or ≤5 sandwave interactions.	Limited distance of sandwave fields and/or ≤3 sandwave interactions.
	Seabed Slopes	>15° slope	≤10°–15° slope	≤5°–10° slope	≤5° slope
	Seabed Obstructions	Significant obstructions preventing installation.	Obstructions hampering installation.	Minor obstructions hampering installation.	No obstruction.

Type of Constraint	Category	Black	Red	Amber	Green
Environmental	Nature Conservation Sites	Intersects internationally or nationally protected habitats and species i.e. Marine Conservation Zones (MCZ), Special Areas of Conservation (SAC), Special Protection Areas (SPA), National Nature Reserves, Ramsar Sites, Sites of Specialist Scientific Interest (SSSI).	Within 2 km of an internationally or nationally protected habitat or species.	Within 1 km of an internationally or nationally protected habitats and species.	Beyond all internationally or nationally protected habitats and species.
	Archaeology	≤50 m of known wreck	≤100 m of known wreck	≤250 m of known wreck	≥250 m from known wreck
	Navigational Aids	≤500 m of aid	≤1000 m of aid	≤2000 m of aid	≥2000 m of aid
	Shipping Lanes	Intersects high volume shipping lane.	None	None	Avoids high volume shipping lane.
	Recreation	Intersects known recreation area.	None	None	Avoids known recreation area.
	Anchorages	≤500 m of anchorage.	≤1000 m of anchorage.	≤2000 m of anchorage.	≥2000 m of anchorage.
Commercial	Oil & Gas Infrastructure	None	≥5 crossings	3–5 crossings	≤2 crossings
	Electrical Export Cables	None	Agreement for crossing required.	Agreement for proximity required.	No proximity or crossing agreements required.
	Commercial Fisheries	None	Average ICES total value of landings (all gears, 2016) >3.2m GBP.	Average ICES total value of landings (all gears, 2016) 200k-3.2m GBP.	Average ICES total value of landings (all gears, 2016) <200k GBP.
	Carbon Capture & Storage	None	Obstructions hampering installation.	Minor obstructions hampering installation.	No obstruction.

Table 9: Offshore Export Cable Corridor BRAG Assessment.

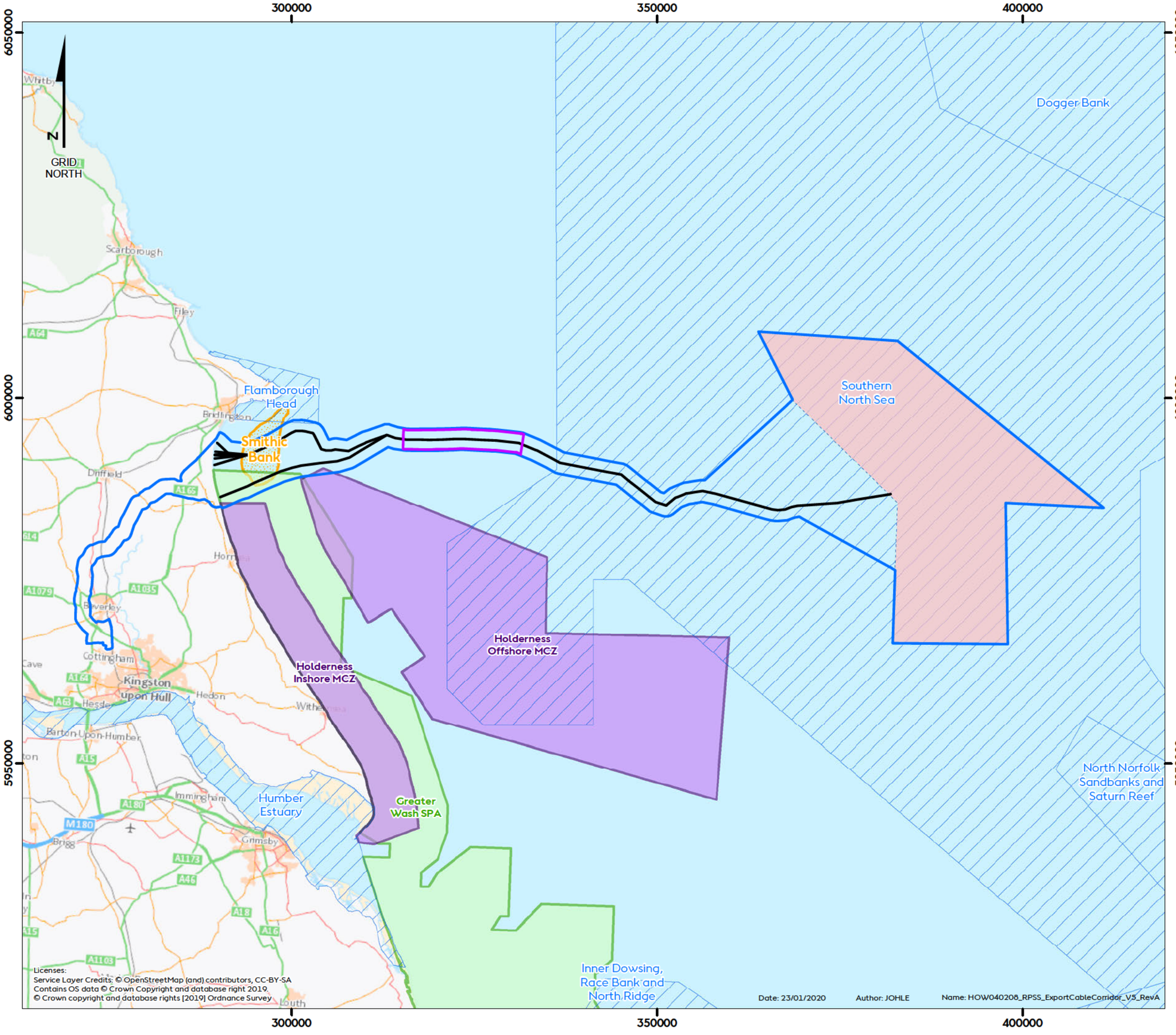
Type of Constraint	Category	Route One	Route Two	Route Three	Route Four
Technical Review	Cable Length	103 km	102.5 km	106.5 km	107.5 km
	Geology	6.2 km of muddy sandy gravel.	6.2 km of muddy sandy gravel.	6.4 km of muddy sandy gravel	6.4 km of muddy sandy gravel.
	Bathymetry	≥15 m depth	≥15 m depth	≥15 m depth	≥15 m depth
	Seabed Features	8 km sandwave field, interacts with 3 sandwaves.	10.1 km sandwave field, interacts with 3 sandwaves.	3.7 km sandwave field.	5 km sandwave field, interacts with 6 sandwaves.
	Seabed Slopes	≤5° slope	≤5° slope	≤5° slope	≤5° slope
	Seabed Obstructions	Relatively high obstruction density.	Low number of obstructions.	Low number of obstructions.	Medium density of obstructions with possible bite points.
Environmental Review	Nature Conservation	Offshore avoids the MCZ, SAC and SPA. Nearshore crosses the sandbank feature Smithic Bank.	Offshore avoids the MCZ, SAC and SPA. Nearshore crosses the sandbank feature Smithic Bank.	Offshore avoids the MCZ, SAC and SPA. Nearshore crosses the sandbank feature Smithic Bank.	Offshore avoids the MCZ, SAC and SPA. Close to MCZ. Nearshore crosses the Greater Wash SPA and the sandbank feature Smithic Bank.
	Archaeology	Offshore avoids all known wreck sites. Nearshore one landfall within 100 m proximity to two	Offshore avoids all known wreck sites. Nearshore one landfall within 100 m proximity to two	Offshore avoids all known wreck sites. Nearshore one landfall within 100 m proximity to two	Offshore avoids all known wreck sites. Nearshore one landfall within 100 m proximity to two

Type of Constraint	Category	Route One	Route Two	Route Three	Route Four
		wrecks and one within 250m.	wrecks and one within 250m.	wrecks and one within 250m.	wrecks and one within 250m.
	Navigational Aids	None identified.	None identified.	None identified.	None identified.
	Shipping Lanes	All routes equally affected.	All routes equally affected.	All routes equally affected.	All routes equally affected.
	Recreation	None identified.	None identified.	None identified.	None identified.
	Anchorages	None identified.	None identified.	None identified.	None identified.
Commercial Review	Oil & Gas Infrastructure	Avoids existing offshore infrastructure crossings.	Avoids existing offshore infrastructure crossings.	Avoids existing offshore infrastructure crossings though suspect future developments coming forward.	Avoids existing offshore infrastructure crossings though suspect future developments coming forward.
	Electrical Export Cables	All routes require one major crossing.	All routes require one major crossing.	All routes require one major crossing.	All routes require one major crossing.
	Commercial Fisheries	Average ICES total value of landings (all gears, 2016) 200k-3.2m GBP.	Average ICES total value of landings (all gears, 2016) 200k-3.2m GBP.	Average ICES total value of landings (all gears, 2016) 200k-3.2m GBP.	Average ICES total value of landings (all gears, 2016) >3.2m GBP.
	Carbon Capture & Storage	Proximity to White Rose CCS proposed project.	Proximity to White Rose CCS proposed project.	None identified.	None identified.

Hornsea Four

Figure 10

Offshore Export Cable Corridor Version 5



- Scoping Boundary
- Hornsea Four Array Area for Lease (AfL)
- Export Cable Version 5
- HVAC search area (at Scoping)
- Special Area of Conservation (SAC)
- Marine Conservation Zone (MCZ)
- Greater Wash Special Protection Area (SPA)
- Smithic Bank

Coordinate system: ETRS 1989 UTM Zone 31N

Scale@A3: 1:500,000

0 5 10 20 Kilometres

0 2.25 4.5 9 Nautical Miles

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5 PEIR

5.1 Introduction

5.1.1.1 At the PEIR stage, the aim was to present a refined offshore ECC, HVAC booster station search area and wind farm array area, through the detailed assessment of technical, commercial and environmental constraints, to support sufficient confidence in commissioning site specific surveys and enabling a full environmental impact assessment (EIA).

5.2 Offshore Export Cable Corridor Refinement

5.2.1 Refinement

5.2.1.1 At PEIR the offshore ECC was reduced from 3 km to 1.5 km wide (Version 6 **Figure 11**) with a widening to 3 km at the offshore HVAC booster station search area.

5.2.1.2 In order to establish a preferred offshore ECC boundary at PEIR, the following principles were applied to the route refinement process on offshore ECC Version 5:

- Minimising overlap with challenging ground conditions; and
- Minimising the number of cable/pipeline crossings, and ensuring they occur at a 90-degree crossing angle.

5.2.2 Justification

5.2.2.1 The offshore ECC continued to develop following receipt of further site-specific data in 2018 and 2019. The objective of final route engineering is to finalise the offshore ECC based on conceptual ground modelling. This stage used high-resolution geophysical data to inform a conceptual ground model.

5.2.2.2 Refer to **Table 10** which describes the alter-courses undertaken throughout the offshore ECC route refinement process as referenced in **Figure 11**.

5.2.3 Technical Review

5.2.3.1 Based on ground data, the offshore ECC was routed to avoid obstacles (e.g. significant sand waves), to follow sandwave troughs and to minimise remedial burial activities.

5.2.3.2 A temporary working area of 500 m either side of the offshore ECC was incorporated into the offshore ECC. This distance will ensure any construction vessels can operate fully within the corridor without risk of anchors or jack-up legs being out with the Hornsea Four DCO order limits.

5.2.4 Environmental Review

5.2.4.1 There were no further nature conservation sites to constrain development.

5.2.5 Commercial Review

5.2.5.1 The following commercial constraints were considered and reflected in Version 6 (**Figure 11**):

- Adjusted offshore ECC at Creyke Beck Offshore Windfarm;
- Moved offshore ECC to avoid potential wrecks;
- Adjusted offshore ECC to avoid oil and gas infrastructure;
- Adjusted offshore ECC to line up crossing of existing pipeline infrastructure to 90 degrees;
- Reduced offshore ECC funnel at array to avoid having additional existing pipeline crossings;
- Southern boundary offshore ECC funnel adjusted to avoid existing oil and gas infrastructure; and
- Northern boundary offshore ECC funnel adjusted to avoid large sandwaves.

5.3 Offshore HVAC Booster Station Refinement

5.3.1 Refinement

5.3.1.1 At PEIR the HVAC booster station search area was reduced by half to a corridor of 3 km wide and 8 km long (24 km^2 area) (Version 6 **Figure 11**).

5.3.2 Justification

5.3.2.1 In electrical terms, the optimum position for a HVAC booster station along the offshore ECC is midway between the offshore and onshore substation within the range of 45% to 55% of the total cable length (combining both on and offshore export cable lengths).

5.3.2.2 Hornsea Four requires up to three HVAC booster stations within this area, each a minimum separation of at least 100 m.

5.3.2.3 For the purpose of the HVAC booster station search area refinement process, layout may be in a grid, string or randomised. In order to establish a refined search area, the following key constraints were considered:

- Seabed bathymetry;
- Existing shipping traffic; and
- Existing offshore infrastructure.

5.3.3 Technical Review

5.3.3.1 Bathymetry is a development constraint in water depths 50 m or greater and/or seabed sediments characterised by exposed bedrock or heterogenous Quaternary till units with a high volume of boulders.

5.3.3.2 The Hornsea Four HVAC booster station search area was characterised by a reasonably flat seabed with water depth around 50 m and so was largely deemed wholly developable.

5.3.4 Environmental Review

5.3.4.1 Moving the reduced HVAC Booster Station search area east, away from the shore, further reduces potential visual impact from the shore, potential interaction with nearshore coastal processes and avoids the busiest shipping main routes (see **Volume A5, Annex 5.7.1: Navigational Risk Assessment**).

5.3.5 Commercial Review

5.3.5.1 Existing shipping traffic was identified as a potential constraint to the refinement of the HVAC booster station search area. Available shipping route data indicated the western extent of the search area displayed increased shipping intensity relative to other areas.

5.3.5.2 While it should be noted that the shipping data was indicative, and did not constitute fixed shipping lanes, it was treated as a potential constraint to development.

5.3.5.3 Additionally, within the eastern boundary of the HVAC booster station search area, an existing gas pipeline was identified.

5.4 Array Area Refinement

5.4.1 Refinement

5.4.1.1 At PEIR the array area was reduced in order to reduce the potential for impacts on the visiting seabird population (Version 6 **Figure 11**).

5.4.2 Justification

5.4.2.1 The Hornsea Four AfL area was 846 km^2 at the Scoping phase of project development. In the spirit of keeping with Hornsea Four's approach to proportionate Environmental Impact Assessment (EIA), the project has given due consideration to the size and location (within the existing AfL area) of the final project that is being taken forward to Development Consent Order (DCO) application. This consideration is captured internally as the "Developable Area Process", which includes physical, biological and human constraints in refining the developable area, balancing consenting and commercial considerations with technical feasibility for construction.

5.4.2.2 The combination of Hornsea Four's proportionality in EIA and developable area process has resulted in a marked reduction in the Order Limits taken forward at the point of DCO application. Hornsea Four adopted a major site reduction from the AfL presented at Scoping (846 km^2) to the Preliminary Environmental Information Report (PEIR) boundary (600 km^2), with a further reduction adopted for the Environmental Statement (ES) and DCO application (468 km^2) due to the results of the PEIR, technical considerations and stakeholder feedback.

5.4.2.3 The evolution of the AfL is further detailed in the **Volume 1, Chapter 3: Site Selection and Consideration of Alternatives**.

5.4.3 Technical Review

5.4.3.1 Bathymetry is a development constraint in water depths 50 m or greater and/or seabed sediments characterised by exposed bedrock or heterogenous Quaternary till units with a high volume of boulders.

5.4.3.2 Across Hornsea Four water depths vary from 25-62 m throughout the array, being shallowest in the southern part and deepest in the north-eastern part of the site. The deepest water depths, whilst less favourable for foundation installation, are technically feasible and therefore no water depth constraint was applied.

5.4.4 Environmental Review

5.4.4.1 There were no nature conservation sites which would directly constrain development of the array area.

5.4.4.2 However, baseline ornithological survey data identified considerable ornithological interest within the array area, concentrated around the southernmost and northernmost areas of the site. In consultation with the statutory nature conservation body and other relevant

stakeholders, Hornsea Four recommended a refined developable array area in order to reduce the potential for impacts on the visiting seabird population (see Version 6 **Figure 11**).

5.4.5 Commercial Review

5.4.5.1 Shipping was a consideration to the refinement of the array area, as available shipping data indicated a number of existing shipping routes intersect the array site. Whilst data did not identify fixed shipping lanes, the data was a consideration in array area refinement and considerable consultation with shipping operators was undertaken.

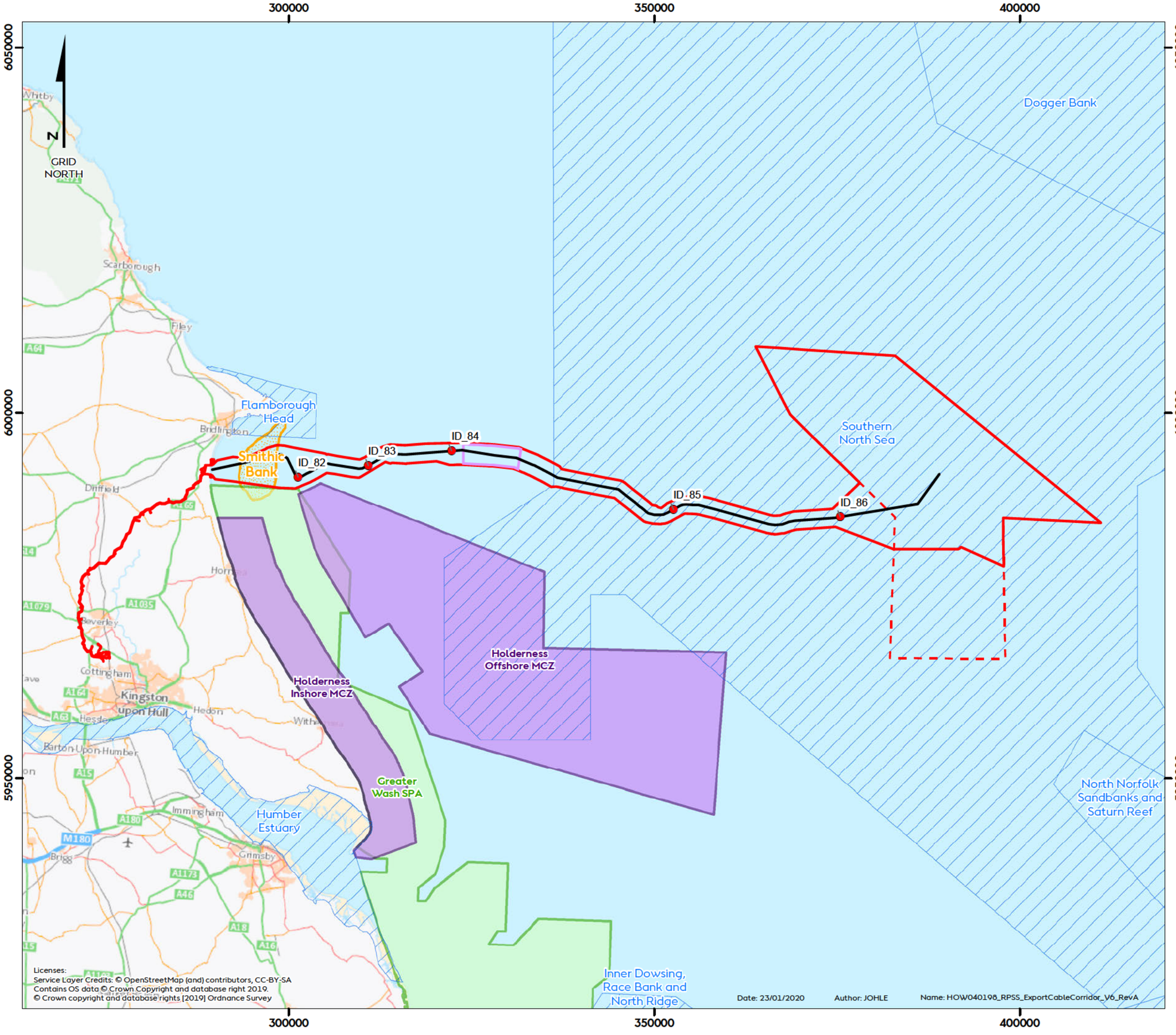
5.4.5.2 A number of offshore infrastructure assets are located within proximity to the array area and were considered through consultation with asset owners / operators throughout the EIA process.

5.4.5.3 The final array area taken forward at PEIR is presented as Version 6 (**Figure 11**).

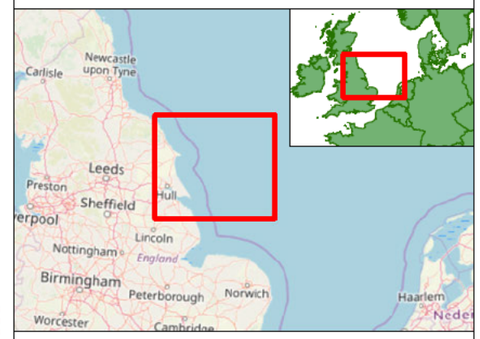
Hornsea Four

Figure 11

Offshore Export Cable Corridor Version 6



- PEIR Boundary
- Change Comment
- Export Cable Version 6
- Hornsea Four Array Area (AFL)
- HVAC search area (at PEIR)
- Special Area of Conservation (SAC)
- Marine Conservation Zone (MCZ)
- Greater Wash Special Protection Area (SPA)
- Smithic Bank



Coordinate system: ETRS 1989 UTM Zone 31N

Scale@A3: 1:500,000

0 4.75 9.5 19 Kilometres

0 2.25 4.5 9 Nautical Miles

REV	REMARK	DATE
	First issue for PEIR	22/05/2019
A	Updated for DCO	07/11/2019

Offshore Export Cable Corridor Version 6
Document no: HOW040198
Created by: XDAOO
Checked by: JOHLE
Approved by: JULCA

Ørsted

6 DCO Application

6.1 Introduction

6.1.1.1 At DCO application the aim of route planning and site selection is to undertake a review of the preferred offshore ECC, HVAC booster station search area and array area as presented at PEIR in light of stakeholder feedback through Section 42 and 47 consultations and further review of technical, commercial or environmental site-specific data.

6.2 Offshore Export Cable Corridor

6.2.1 Refinement

6.2.1.1 The offshore ECC remains largely consistent with that presented at PEIR with very minor refinements made at the landfall funnel, the HVAC booster station search area and the array area funnel (Version 7 **Figure 12**).

6.2.2 Justification

6.2.2.1 Refinement to the offshore ECC, the HVAC booster station search area and the array area in response to feedback from Section 42 and 47 consultation stakeholders further informed the offshore design process.

6.2.2.2 Refer to **Table 10** which describes the alter-courses undertaken throughout the offshore ECC route refinement process as referenced in **Figure 12**.

6.2.3 Technical Review

6.2.3.1 The removal of landfall option A3 meant a reduction in offshore ECC at the area approaching landfall.

6.2.4 Environmental Review

6.2.4.1 The cable crossing at Dogger Bank Creyke Beck was moved further east, away from the Smithic Bank in order to alleviate concerns raised during Section 42 consultation from statutory consultees.

6.2.5 Commercial Review

6.2.5.1 The offshore ECC underwent a number of minor refinements to accommodate third party offshore infrastructure. A minor reroute in the vicinity of the Platypus pipeline enabled a 90 degree crossing. The offshore ECC was narrowed in the vicinity of the proposed Viking Link interconnector cable. Following consultation with Premier Oil, both the offshore ECC and the HVAC booster station search area were reduced to increase spacing available to the Tolmount Main offshore platform.

6.3 HVAC Booster Station Search Area

6.3.1 Refinement

6.3.1.1 At DCO application the HVAC booster station search area width was reduced to 2.5 km wide and 8 km long (20 km^2 area) (Version 7 **Figure 12**).

6.3.2 Justification

6.3.2.1 Minor adjustments to the HVAC booster station search area aimed to ensure sufficient size for up to three HVAC booster stations can be accommodated whilst using additional bathymetry data and assessment of ground conditions, taking into consideration the proximity of sandwaves and neighbouring existing offshore infrastructure.

6.3.3 Technical Review

6.3.3.1 No new impact on technical aspects.

6.3.4 Environmental Review

6.3.4.1 No new impact on environmental aspects.

6.3.5 Commercial Review

6.3.5.1 Following consultation with Premier Oil, both the offshore ECC and the HVAC booster station search area were reduced to increase spacing available to the Tolmount Main offshore platform.

6.3.5.2 The reduced HVAC search area will have additional benefits to the commercial shipping sector. The search area has been refined by approximately 74% since Scoping, with the main consideration being to avoid the highest density vessel traffic at the original western extent of the HVAC search area. This change significantly reduces the potential collision risk to third-party vessels since disruption to the heavily trafficked commercial routes along the UK east coast is minimised.

6.4 Array Area Refinement

6.4.1 Refinement

6.4.1.1 The combination of Hornsea Four's proportionality in EIA and developable area process has resulted in a marked reduction in the Order Limits taken forward at the point of DCO application. Hornsea Four adopted a major site reduction from the AfL presented at Scoping (846 km^2) to the PEIR boundary (600 km^2), with a further reduction adopted for the ES and DCO application (468 km^2, shown in **Figure 12**) due to the results of the PEIR, technical considerations and stakeholder feedback.

6.4.2 Justification

6.4.2.1 Stakeholder feedback received at Section 42 and 47 consultations lead Hornsea Four to reconsider the commercial impacts of existing shipping route deviations caused by the proposed Hornsea Four array area at PEIR.

6.4.2.2 In response Hornsea Four undertook additional extensive consultation with the shipping industry and statutory authorities to identify a suitable mitigation solution. The implementation of a gap between Hornsea Two and Hornsea Four, secured through a reduction in the DCO Order Limits, facilitated the continued safe passage of vessel traffic between the two projects (refer to **Volume A2, Chapter 7: Shipping and Navigation**).

6.4.2.3 The final reduction within the north of the AfL was undertaken in an effort to reduce/eliminate the potential for Adverse Effect on Integrity (AEoI) upon the guillemot and razorbill features of the Flamborough and Filey Coast (FFC) Special Protection Area (SPA) by removing areas of high auk (guillemots and razorbills) density to the northwest of the AfL and thereby significantly reducing bird numbers within the final development footprint.

6.4.3 Technical Review

6.4.3.1 No impact on technical aspects.

6.4.4 Environmental Review

6.4.4.1 No impact on environmental aspects.

6.4.5 Commercial Review

6.4.5.1 Section 42 consultation feedback from both shipping operators and representative bodies indicated a potential for commercial transboundary impacts given the direct consequence of deviation, increased distance and therefore increased journey time and fuel use.

6.4.5.2 Hornsea Four responded by proposing and consulting on a 2.2 nm gap between the Hornsea Two and Hornsea Four projects, secured through an update to the DCO Order Limits presented at DCO application and the supporting EIA and Navigational Risk Assessment (NRA). The inclusion of a gap was considered to be the most effective mitigation for the potential commercial impact and new consultation to ratify its design both for navigational safety and commercial purposes was undertaken through the NRA Hazard Workshop process (refer to **Volume A2, Chapter 7: Shipping and Navigation**).

6.4.5.3 Taking into account the positive consultation undertaken with relevant stakeholders (including the principle vessel operator) and commitments included as part of Hornsea Four, it was concluded that the gap would not pose a significant risk to safe navigation and would be carried forward at DCO application.

7 Conclusion

7.1.1.1 The final offshore ECC, HVAC booster station search area and array area, as presented within this Annex as Version 7 (**Figure 12**), has been derived through a combination of stakeholder feedback, technical, commercial and environmental considerations balanced alongside engineering limitations.

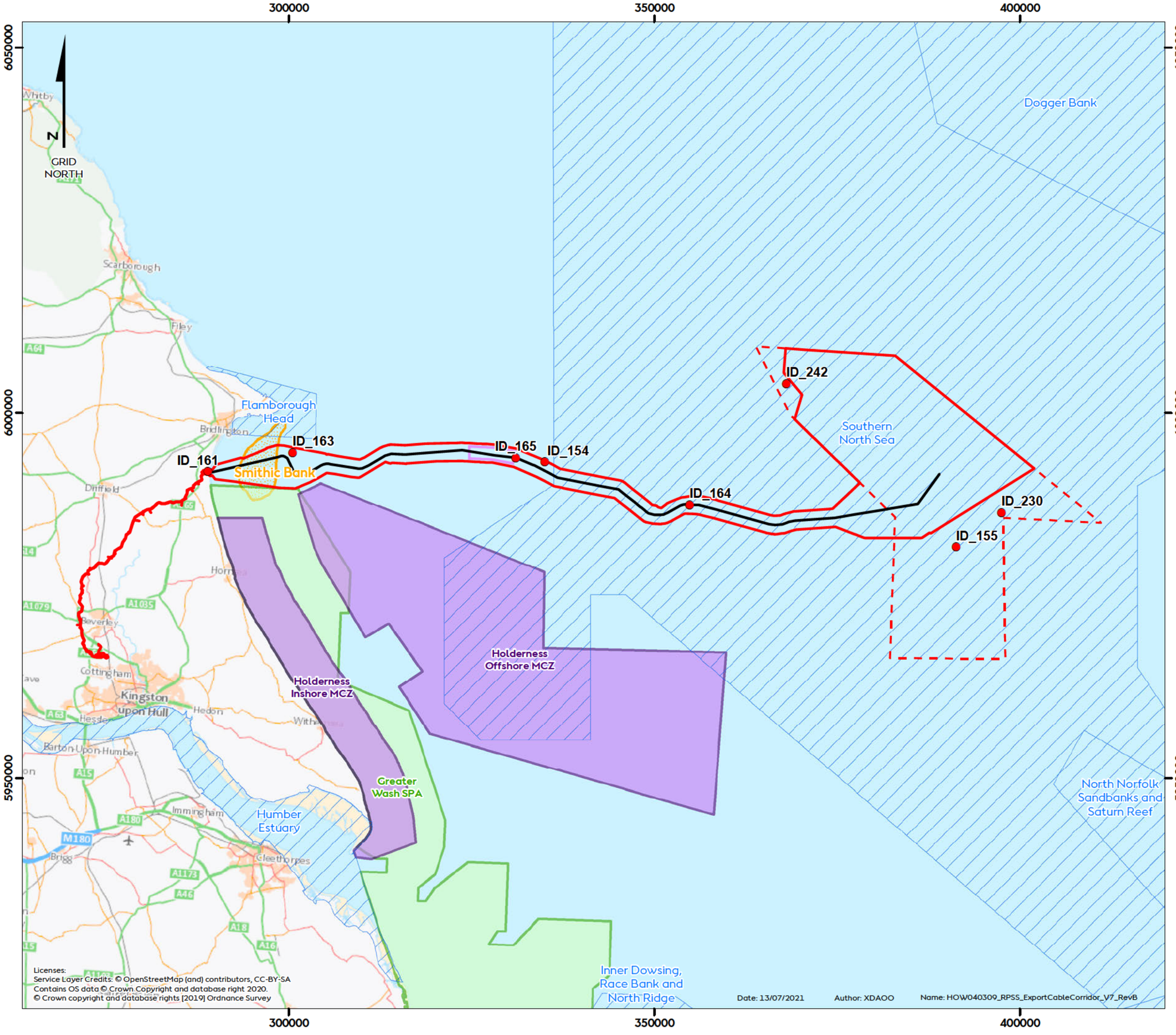
7.1.1.2 The information presented and the decisions made were conducted by a multi-disciplinary team, taking into consideration stakeholder feedback and detailed site specific data where available.

7.1.1.3 The final Order Limits taken forward for this application for Development Consent is shown in **Volume 1, Chapter 3: Project Description**.

Hornsea Four

Figure 12

Offshore Export Cable Corridor Version 7



Order Limits

Export Cable Version 7

Hornsea Four Array Area (AFL)

HVAC Search Area (at DCO)

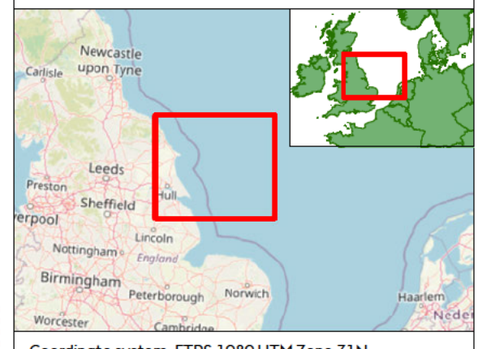
Change Comment

Special Area of Conservation (SAC)

Marine Conservation Zone (MCZ)

Greater Wash Special Protection Area (SPA)

Smithic Bank



Coordinate system: ETRS 1989 UTM Zone 31N

Scale@A3: 1:500,000

0 5 10 20 Kilometres

0 2.5 5 10 Nautical Miles

REV	REMARK	DATE
	First issue for DCO	11/11/2019
A	Revised array area in south east corner	09/10/2020
B	Revised array area in north west corner	13/07/2021

Offshore Export Cable Corridor Version 7
Document no: HOW040198
Created by: XDAOO
Checked by: JOHLE
Approved by: JULCA

Ørsted

Date: 13/07/2021 Author: XDAOO Name: HOW040309_RPSS_ExportCableCorridor_V7_RevB

Table 10: Hornsea Four Offshore Export Cable Corridor Route Refinement.

Change ID	Reason for offshore ECC re-routing
ID_01	End of Intertidal Zone.
ID_02	5m Depth Contour.
ID_03	A disused spoil ground lies to the North marked by a west cardinal mark.
ID_04	10 m depth contour. Route is set to East.
ID_05	Closest point of the MCZ is 730 m. Route set to East by North. Wreck avoidance.
ID_06	Route varies East by North through South East to East by South. Wreck avoidance.
ID_07	Route set to South East – Wreck and shoal avoidance.
ID_08	Closest point of the MCZ is 500 m. Route set to East South East, aligning for crossing.
ID_09	Pipeline crossing.
ID_10	Route set to East by South.
ID_11	Route set to South East by South – Aligning for crossings.
ID_12	Pipeline Crossing.
ID_13	Pipeline Crossing.
ID_14	Route Set to North East – Aligning for crossing.
ID_15	Pipeline crossing.
ID_16	Route set to East by South. Paralleling pipeline.
ID_17	Closest point to pipeline 1,400 m. Route set to East by North. Heading for array area.
ID_18	The beach is within a designated MCZ. A firing practice area lies to the North and a foul area to the South. From the beach, the route is set to North East by East.
ID_19	The end of the intertidal zone.
ID_20	The 5 m depth contour.
ID_21	Closest point to firing practice area extremity 300 m. Closest point to foul area 1000 m.
ID_22	The 10 m depth contour.
ID_23	Route exits MCZ.
ID_24	CPA foul area extremity: 700 m.
ID_25	Route set to East.
ID_26	Route enters MCZ.
ID_27	Route varies from East to North to East North East: Wreck and sand shoal avoidance.
ID_28	Route set to East by South: aligning for crossing.
ID_29	Pipeline Crossing, route exits MCZ.
ID_30	Route set to South East by East. Aligning for crossing and crossing avoidance.
ID_31	Route enters MCZ.
ID_32	Pipeline crossing.
ID_33	Route exits MCZ.
ID_34	Route set to East North East (Links to southern route).
ID_35	Route set to East South East. Aligning for crossing.
ID_36	Pipeline crossing.
ID_37	Route set to East North East. Heading for array area.
ID_38	The beach is within a designated MCZ. From the beach the route is set to East North East.
ID_39	End of intertidal zone.
ID_40	5 m depth contour.

Change ID	Reason for offshore ECC re-routing
ID_41	10 m Depth contour.
ID_42	Route set to East South East avoiding Westermost Rough wind farm.
ID_43	Route exits MCZ.
ID_44	Closest point to Westermost Rough 730 m.
ID_45	Route set to East North East. Avoiding Westermost Rough and wrecks.
ID_46	Closest point to Westermost Rough 1,100 m.
ID_47	Route set to East. Aligning for crossing. Route enters MCZ.
ID_48	Pipeline crossing.
ID_49	Route set to North East. Wreck avoidance.
ID_50	Route set to South East by East. Aligning for crossings.
ID_51	Pipeline crossing.
ID_52	Route set to E. Passing between oil platform and wrecks.
ID_53	Closets point to oil platform 1600 m.
ID_54	Route set to North East, wreck avoidance.
ID_55	Route exits MCZ.
ID_56	Route set to East, wreck avoidance.
ID_57	Route heads North East to stay away from MCZ.
ID_58	Route heads North East to avoid multiple crossings heading into the array. Avoids wrecks to North.
ID_59	Route heads North East, avoiding wrecks.
ID_60	Route heads East to line up for crossing.
ID_61	Route heads towards array, avoiding wrecks and wells.
ID_62	Route heads roughly East, ready to make crossing at correct angle.
ID_63	Route carries on East, staying away from wrecks, avoiding double asset crossing to South East.
ID_64	Route heads North East to line up for pipeline crossing.
ID_65	Route heads East, heading for array.
ID_66	Route heads South East, heading for pipeline crossing.
ID_67	Route fans out to approach all landfalls in zone A.
ID_68	Route bends to approach Creyke Beck A & B crossing at 90-degree angle.
ID_69	Route crosses Creyke Beck A & B cable corridor.
ID_70	Route bends away from Creyke Beck A & B towards array.
ID_71	Route splits to allow for different options heading to the array.
ID_72	Route bends North East to avoid having to make multiple crossings.
ID_73	Route heads East South East towards array, lining up for crossing.
ID_74	Route heads West, to avoid areas of hard substrate.
ID_75	Route heads North East to avoid crossing.
ID_76	Route heads East towards array.
ID_77	Route heads East South East, creating alternative pipeline crossing location.
ID_78	Route heads South East, lining up for double asset crossing.
ID_79	Route bends North East heading for crossing.
ID_80	Route moved to north to keep as far away from the MCZ as possible.
ID_81	Pipeline crossing.
ID_82	Crossing Creyke Beck A & B in shallower water. Avoiding wrecks surrounding former crossing location.

Change ID	Reason for offshore ECC re-routing
ID_83	Moved cable south to avoid P&A well.
ID_84	Adjusted cable to line-up for crossing of pipeline at 90 degrees.
ID_85	Ensuring crossing pipeline at 90 degrees.
ID_86	Reduced array approach ECC funnel to avoid additional pipeline crossings when approaching the array. Southern boundary of funnel moved to north of Babbage platform and avoids largest sandwaves in the northern part of the funnel.
ID_154	Refined offshore temporary and permanent offshore ECC to increase temporary margin by Premier Oil Tolmount platform.
ID_155	Trim fan area adjacent to the proposed Viking Link corridor.
ID_161	Removal of A3 landfall compound.
ID_162	Removal of A3 landfall compound.
ID_163	Adjusting offshore ECC cable crossing east of Smithic Bank.
ID_164	Reroute offshore ECC to cross Platypus pipeline at 90 degrees.
ID_165	Reduced HVAC Booster Station search area to accommodate Premier Oil Tolmount platform.
ID_230	Reduced array area Order Limits between Hornsea Two and Hornsea Four Offshore Wind Farms to accommodate existing shipping traffic.
ID_242	Reduced north western corner of array area Order Limits for ornithological purposes.