Decommissioning Programme for Dudgeon Offshore Wind Farm

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1 Introduction

Dudgeon Offshore Wind Limited (DOWL) received planning consent for the construction of Dudgeon Offshore Wind Farm (DOW) in 2012. A request to vary the Marine Licence was submitted in July 2013 to increase the area of the wind farm; this was supported by the Supplementary Environmental Information (SEI). The variation was approved and a variation to the Marine Licence was received in December 2013.

DOW has consent for a generating capacity of up to 540MW, with the planned capacity of the site predicted to be 402MW. The site will comprise of 67 turbines, one offshore substation and two export cables, each approximately 42km in length which will make landfall at Weybourne Hope. The onshore cable route extends for 47km with the onshore substation located at Necton, Norfolk.

This document presents the Decommissioning Programme for the offshore elements of DOW and is being submitted for approval in accordance with the requirements under Section 105 of the Energy Act 2004. This Decommissioning Programme is applicable to all offshore components of the wind farm including the wind turbines, substation, foundations, export and inter-array cables, scour protection and cable protection, if required.

DOW has a technical design lifetime of 25 years and it is assumed that the timing, methods and costs associated with decommissioning will have developed significantly in this time. This document, therefore, aims to establish and describe the feasibility of decommissioning. The actual methods, durations and costs remain highly uncertain at this stage in the process and, therefore, DOWL will review this programme in the years prior to decommissioning to reflect best practice at the time and the results of any surveys undertaken at the site. The decommissioning procedure will also be subject to the award of a new Marine Licence by the MMO, assuming the current process is still in place at the time of decommissioning.

DOWL is owned by a consortium made up of Statoil (35%), Masdar (35%) and Statkraft (30%), with Statoil acting as the Operator of DOW for both the construction and operation phase of the project. Responsibility for operating and maintaining the two export cables and substation will be transferred to an Offshore Transmission Owner (OFTO). The decommissioning of these assets will be covered by a Decommissioning Programme submitted by the OFTO when appointments have been made. DOWL will ensure that all decommissioning activities are coordinated between the different organisations.

2 Executive Summary

The Energy Act 2004 requires that DOWL prepares and ultimately carries out a decommissioning programme for the DOW. This document constitutes the preliminary decommissioning programme for the offshore components of the project.

The programme is informed and supported by the Environmental Impact Assessment (EIA) and SEI carried out for DOW. The resulting Environmental Statement and SEI provide detailed analysis of the baseline physical, biological and human environment. The assessment of the impact of the project on receptors and stakeholders takes into account decommissioning activities which are consistent with those presented in this document.

In considering the decommissioning programme, DOWL have sought to adhere to the following key principles:

- Safety for all at all times;
- Consideration of the rights and needs of legitimate users of the sea;
- Minimise environmental impact by having regard to the best practicable environmental option;
- Promote sustainable development;
- Adhere to the Polluter Pays Principle;
- Maximise the reuse of materials;
- Commercial viability; and
- Practical integrity.

DOWL's assumed options for decommissioning have been assessed against the guiding principles listed above. A summary of the proposals for decommissioning the offshore components of DOW are outlined in the table below.

Component	Decommissioning Proposal
Wind Turbine/generating equipment	Complete removal from site
Foundations for wind turbines and substation	Cut off at or below seabed and removed
Cables (inter-array and export)	Left *in situ*

The decommissioning programme as currently proposed is to be reviewed and revised throughout the lifecycle of the project to reflect changing circumstances and regulatory requirements, and to incorporate advances in technology and working practices.

3 Background information

3.1 Project Description

DOW is located in the Greater Wash, which was one of the strategic areas identified by the UK Government for Round 2 of offshore wind farm development. The design criteria for DOW is for 25 years, but the agreement for lease from the Crown Estate lasts for 50 years from the Financial Investment Decision (FID) which was undertaken in July 2014.

DOW is located 32km (20 miles) from the town of Cromer on the North Norfolk coast. The wind farm will cover an area of up to 55km^2 in water depths of between 18 – 25m (**Figure 3.1**). It will consist of 67 turbines installed using monopile foundations and a substation with suction bucket jacket foundation. The total capacity will be 402MW.

3.2 Project Programme

Onshore construction started in March 2015 at the substation and along the cable route, whilst the preliminary offshore works started in July 2015. The main offshore construction will start in early 2016, with the wind farm being operational by the end of 2017.

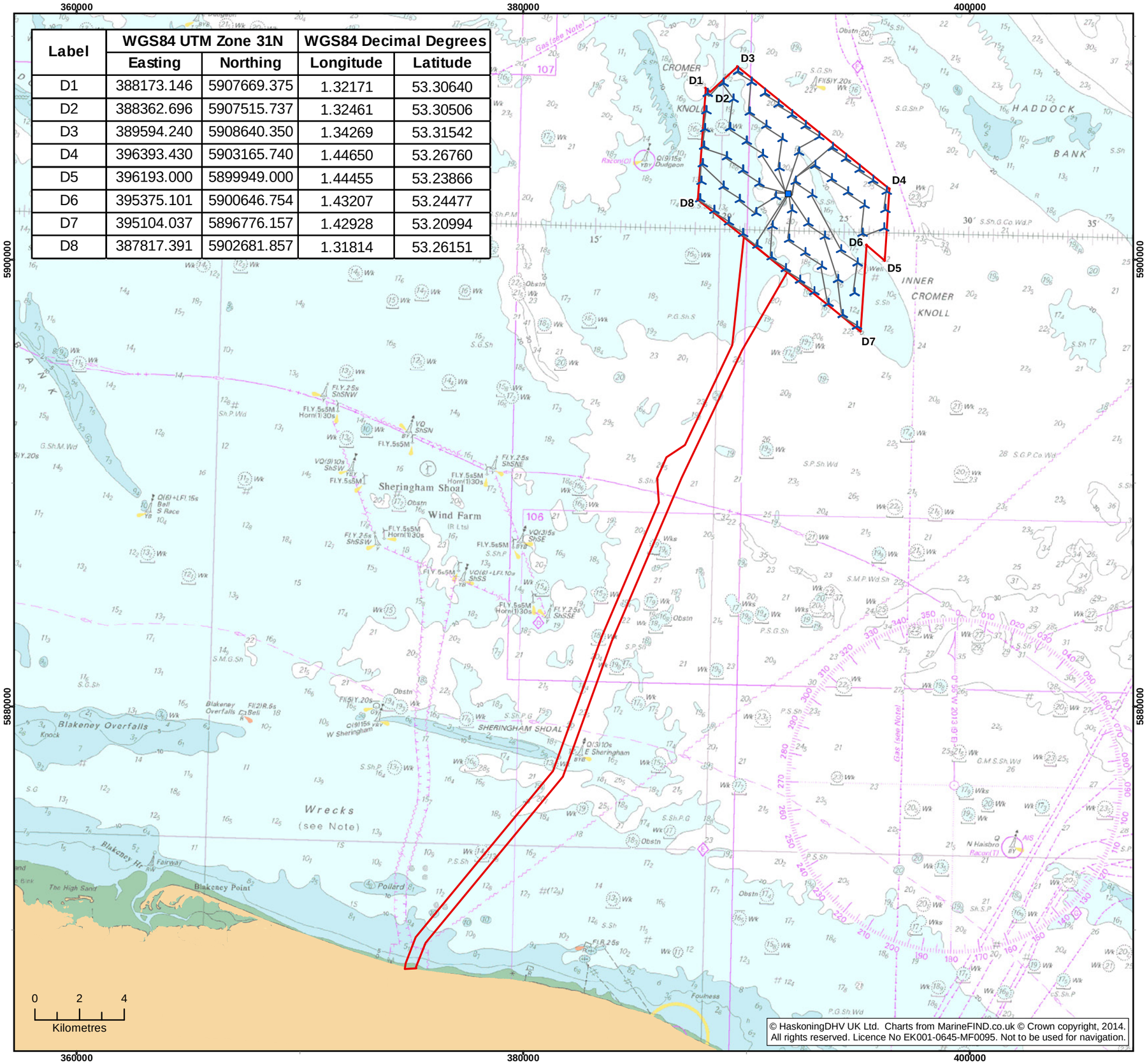
An overview of the construction schedule is provided in the bullet points below.

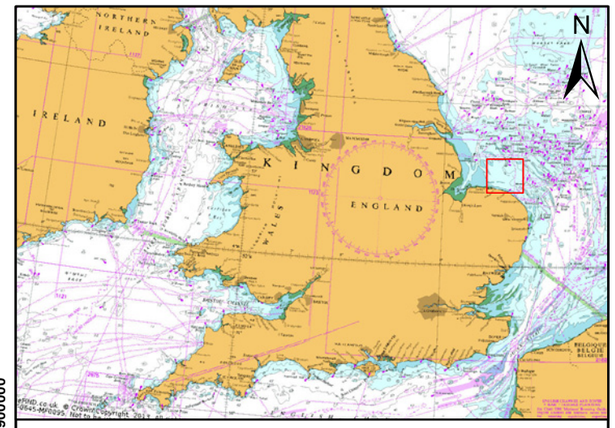
- Onshore substation and onshore cable – March 2015
- UXO survey and clearance activities – May 2015
- HDD work (landfall and offshore) – June 2015
- Filter layer (scour protection) installation at turbine locations – July 2015
- Wind Turbine Generator (WTG) foundations and offshore substation – April 2016
- Export cable installation – March 2016
- Inter-array cable installation – June 2016
- WTG installation – January 2017
- Wind farm operational – October 2017

3.3 Layout of the wind farm and ancillary work

The layout, cable corridor and inter-array cables for DOW will be laid out as in **Figure 3.1**.

Label	WGS84 UTM Zone 31N		WGS84 Decimal Degrees	
	Easting	Northing	Longitude	Latitude
D1	388173.146	5907669.375	1.32171	53.30640
D2	388362.696	5907515.737	1.32461	53.30506
D3	389594.240	5908640.350	1.34269	53.31542
D4	396393.430	5903165.740	1.44650	53.26760
D5	396193.000	5899949.000	1.44455	53.23866
D6	395375.101	5900646.754	1.43207	53.24477
D7	395104.037	5896776.157	1.42928	53.20994
D8	387817.391	5902681.857	1.31814	53.26151





Legend:

- Dudgeon Offshore Wind Farm & Export Cable Corridor
- Interarray Cable Layout
- Substation
- Turbine

Client: Dudgeon Offshore Wind Ltd	Project: Dudgeon Offshore Wind Farm Preconstruction

Title: Location of Dudgeon Offshore Wind Farm

Figure:	Drawing No:				
3.1	PB2438-109-001				
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3.4 Relevant projects and activities

All relevant projects and activities that take place within or in the vicinity of the DOW site have been described in this section. Aggregate extraction areas, marine disposal sites, capital and maintenance dredging sites and water pipelines and outfalls have not been considered as none currently exist in the vicinity of DOW.

The locations off all projects of relevance to DOW can be found in the following figures:

- **Figure 3.2** Offshore wind farms in the vicinity of DOW;
- **Figure 3.3** Oil and gas activities in the vicinity of DOW;
- **Figure 3.4** Military areas, telecommunication cables and dredging sites in the vicinity of DOW;
- **Figure 3.5** Sites of nature conservation in the vicinity of DOW; and
- **Figure 3.6** Nature Conservation Sites near the Export Cable Corridor Landfall.

3.4.1 Offshore wind farms

There are three offshore wind farms (1 operational and 2 planned) near DOW. These are Sheringham Shoal (operational), Race Bank (planned) and Triton Knoll (planned) (**Figure 3.2**). The Triton Knoll and Race Bank infrastructure is greater than 22km from DOW (**Table 3.1**). The export cable corridor for Sheringham Shoal is in close proximity to the Dudgeon export cable, with both cables converging as they approach the onshore transition pit at the DOW landfall. Details of each development have been presented in **Table 3.1**.

Table 3.1 Offshore wind farms in the vicinity of DOW

Site	Developer	Capacity	Status	Distance to nearest DOW feature
Sheringham Shoal	Statoil/Statkraft/GIB	317MW	Operational	Adjacent at landfall
Triton Knoll	RWE	900MW	Consented	22.8km
Race Bank	DONG Energy	580MW	Consented	25.7km

3.4.2 Oil and gas operations and ancillary structures

DOW lies within UK continental Shelf licence blocks 48/22 and 48/23 (see **Figure 3.3**); these blocks are in the process of being re-licensed. These two blocks contain two abandoned wells with an additional two abandoned wells lying adjacent to the south east boundary of DOW. These four wells have been avoided during planning for turbines and cables.

Perenco UK Limited (Perenco) operates almost all of the gas platform facilities in the general area around DOW including the Waveney platform which is nearest the site at 4.89km. Perenco have expressed their opinion that they do not believe that their Waveney operations will be materially adversely affected by DOW.

A further three in-service pipelines are located approximately 0.5km to the east of the site boundary (**Figure** 3.3 and **Table 3.2)**. Avoidance of these pipelines has been incorporated into the final design of DOW.

Table 3.2 In-service gas pipelines close to DOW

Name	Company	Distance and direction
PL 1570 Shearwater to Bacton SEAL (Shearwater Elgin Area Line)	Shell UK	0.49km
PL877 Lancelot to Bacton MEG Line	Perenco UK	0.54km
PL87 Lancelot to Bacton Gas Export Line	Perenco UK	0.54km

3.4.3 Telecommunications cables

Dudgeon lies in an area of low density cabling, with no cables passing directly through the site. Therefore no cable crossings will be required for the project.

3.4.4 Electricity cables

Dudgeon lies in an area of low density cabling, with no active cables passing directly through or within the vicinity of the site.

3.4.5 Military exercise areas

The DOW site does not lie within an area utilised by the MoD as a Military Practice and Exercise area (PEXA). It should however be noted that Block 48/22 has been notified by the MoD as lying either wholly or partly within a MoD training area (DOW ES Section 18) (**Figure 3.4**).

3.4.6 Unexploded ordnance

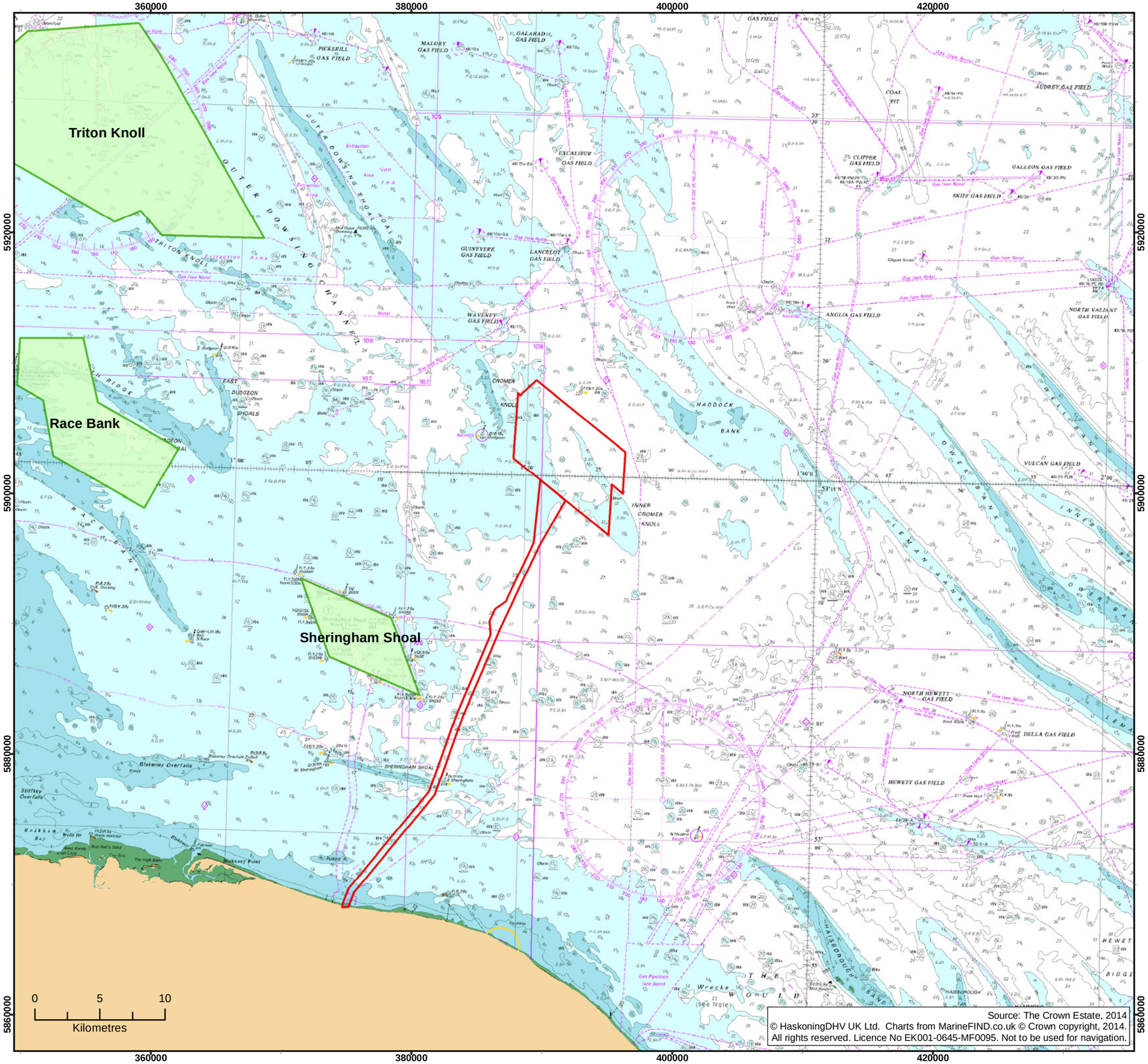
The windfarm site and export cable route have been cleared of UXO prior to commencement of construction.

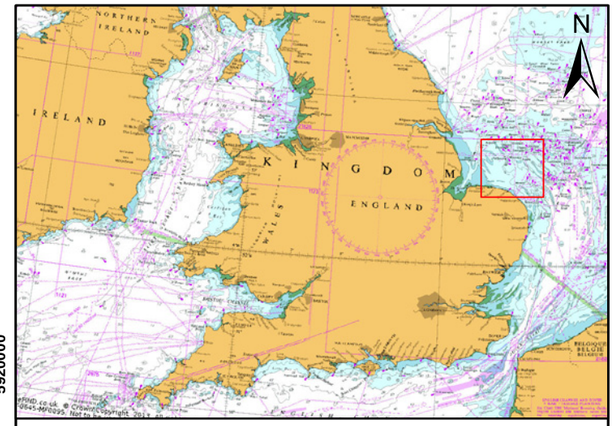
3.4.7 Shipping activities

Section 5 of the SEI and Section 15 of the DOW ES provide a thorough analysis of navigation activity in the vicinity of DOW. This analysis was informed by surveys; a review of existing data; and consultation. A summary of this is presented below.

DOW is removed from the main shipping routes with the highest density passing traffic which are located to the south of the wind farm site. Traffic transiting the site is limited and are considered to be just passing through the site.

There are low level traffic routes passing through the site on a south east/north west transit. It is likely that this route would alter course in the same manner as the other traffic passing through the site, with adequate sea room to pass the perimeter clearly and safely. A small alteration of course for these vessels, while still distant from the proposed wind farm would see them pass clear and wide of the site.





Legend:

- Dudgeon Offshore Wind Farm & Export Cable Corridor
- Offshore Wind Farm

Client:	Project:
Dudgeon Offshore Wind Ltd	Dudgeon Offshore Wind Farm Preconstruction

Title:

Offshore wind farms in the vicinity of DOW

Figure: 3.2 | Drawing No: PB2438-109-004

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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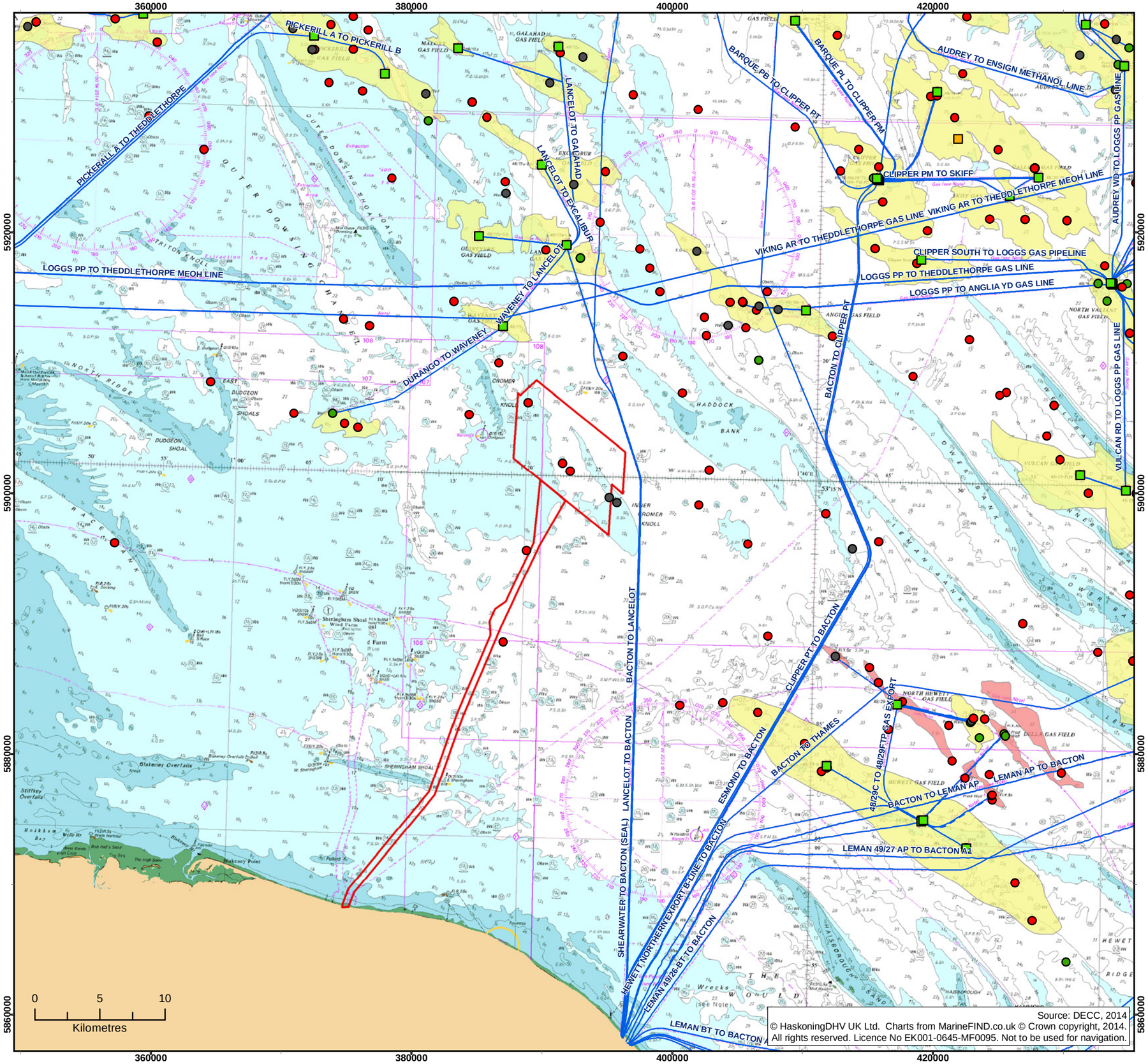

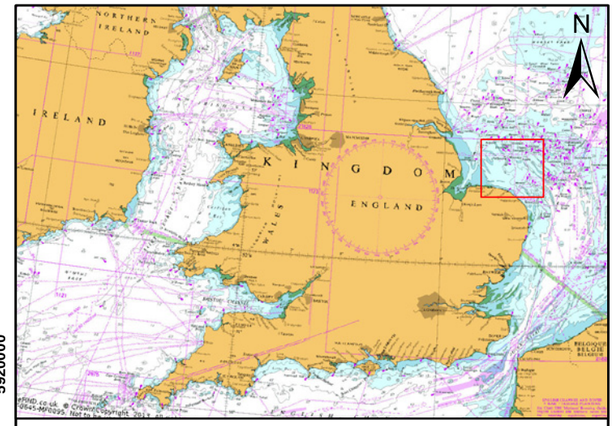

Legend:

- Dudgeon Offshore Wind Farm & Export Cable Corridor

Hydrocarbon Field

- Producing
- Production suspended

Pipeline

- Active
- Not in use

Platform

- Active
- Precommissioned/Proposed

Well

- Abandoned
- Completed
- Suspended

Client:	Project:
Dudgeon Offshore Wind Ltd	Dudgeon Offshore Wind Farm Preconstruction

Title: Oil and gas activities in the vicinity of DOW

Figure:	Drawing No:
3.3	PB2438-109-005

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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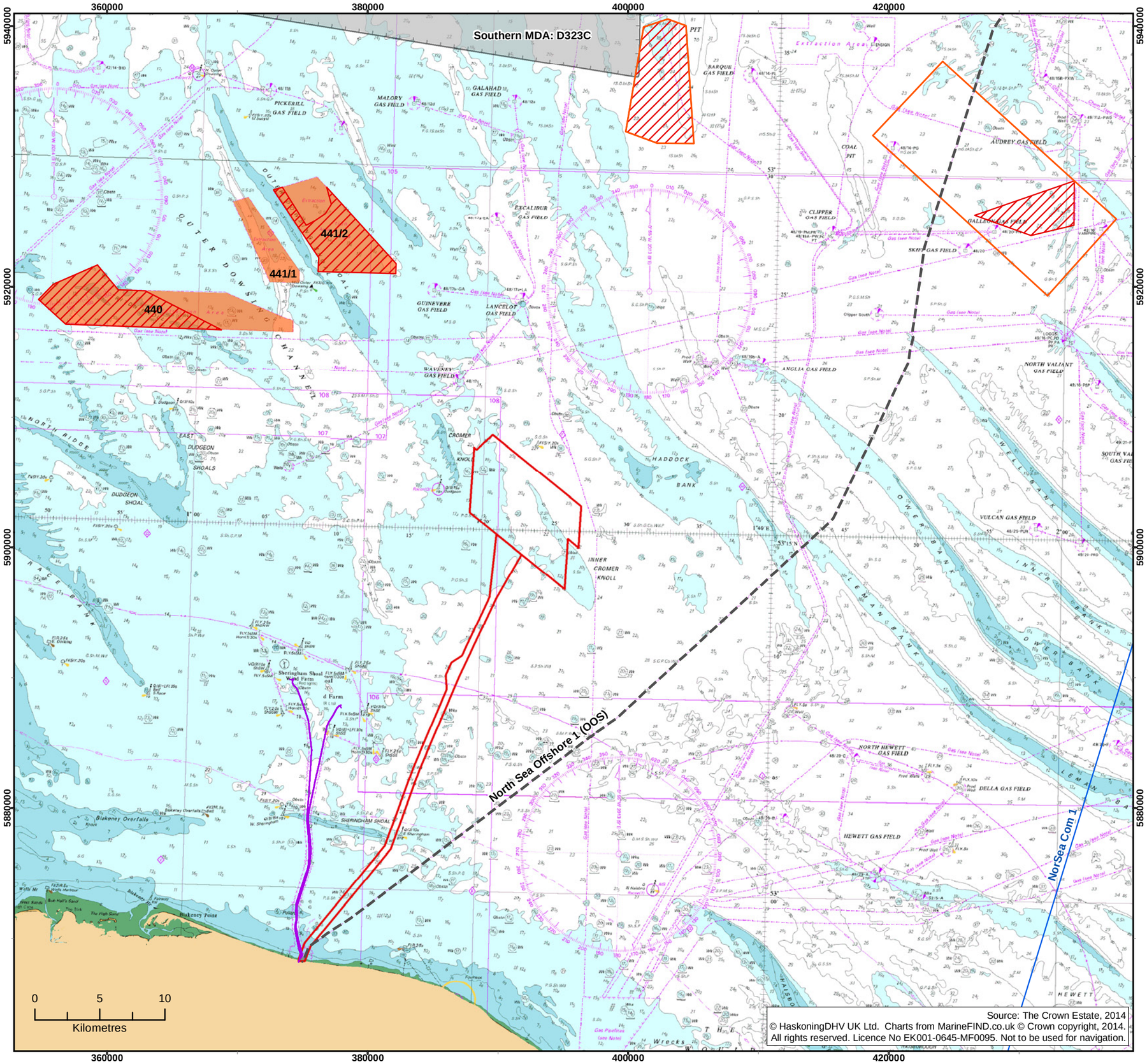

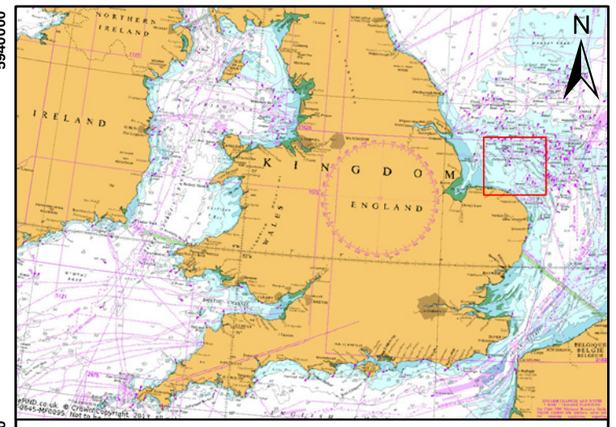

Legend:

- Dudgeon Offshore Wind Farm & Export Cable Corridor
- PEXA
- Aggregates Option Area
- Aggregates Application Area
- Aggregates Licence Area
- Cables
- Offshore Wind Farm Cable
- Out of Service Cable

Client:	Project:
Dudgeon Offshore Wind Ltd	Dudgeon Offshore Wind Farm Preconstruction

Title: Military areas, telecommunication cables and dredging sites in the vicinity of DOW

Figure: 3.4 | Drawing No: PB2438-109-006

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3.4.8 Fishing activity

Section 10 of the SEI and Section 13 of the DOW ES provide a thorough analysis of fishing activity in the vicinity of DOW. A summary of this is presented below.

The fishing fleet within and around the project area predominantly comprises of UK vessels with day boats ranging in length between 10-15m (Pers. comms 2013a).

Shellfisheries are by far the most important fisheries in the region, both in terms of volume and value of catch. Potting is the primary activity in the project area, accounting for the vast majority of fishing effort (days) in rectangle 35F1 from 2000-2012(ICES, 2012). Potting for brown crab (*Cancer pagurus*), whelk (*Buccinum undatum*) and lobster (*Homarus gammarus*) takes place throughout most of the year (Pers. comm 2013a). Significantly smaller contributions are made by demersal and pelagic landings respectively. Demersal species are predominately landed into Lowestoft by large offshore longliners. These vessels operate beyond the location of the project area (Eastern Inshore Fisheries and Conservation Authority (EIFCA), 2013) and were therefore not considered further in the SEI or ES.

The fisheries use of the area has evolved considerably in recent years. In 2008 61% of fishing within Rectangle 35F1 was potting, with 37% from trawlers (predominantly beam with some otter trawls) and 2% longlining. In 2011 whilst potting remained the dominant activity, at 95%, the remaining 5% comprised of otter trawls, gillnets, longlines, beam trawls, Scottish seines, twin trawls and boat dredges (ICES, 2012).

3.4.9 Nature conservation

3.4.9.1 International Designations

Statutory international designated sites in the UK include Ramsar, wetland and Natura 2000 sites, known as Special Protected Areas (SPAs) and Special Areas of Conservation (SACs). SPAs are statutory designated sites that are classified under EU law for rare and vulnerable birds and for regularly occurring migratory species. SACs are areas designated under the Habitats Directive for the protection of habitats and species identified within the Directive. Together, SPAs and SACs form the Natura 2000 network which has been designed to protect the most important areas of wildlife in Europe.

3.4.9.2 National Designations

Nationally designated sites in the UK include Sites of Special Scientific Interest (SSSI) and National Nature Reserves (NNR). SSSIs and NNRs are designated for natural features including wildlife and geology.

All SPAs, SACs, SSSIs and NNRs of relevance to DOW have been listed in **Table 3.3** and are shown in **Figure 3.5** and **Figure 3.6**. Chapter 6 of the ES provides more detailed descriptions on all these sites.

Table 3.3 Areas of conservation of relevance to DOW

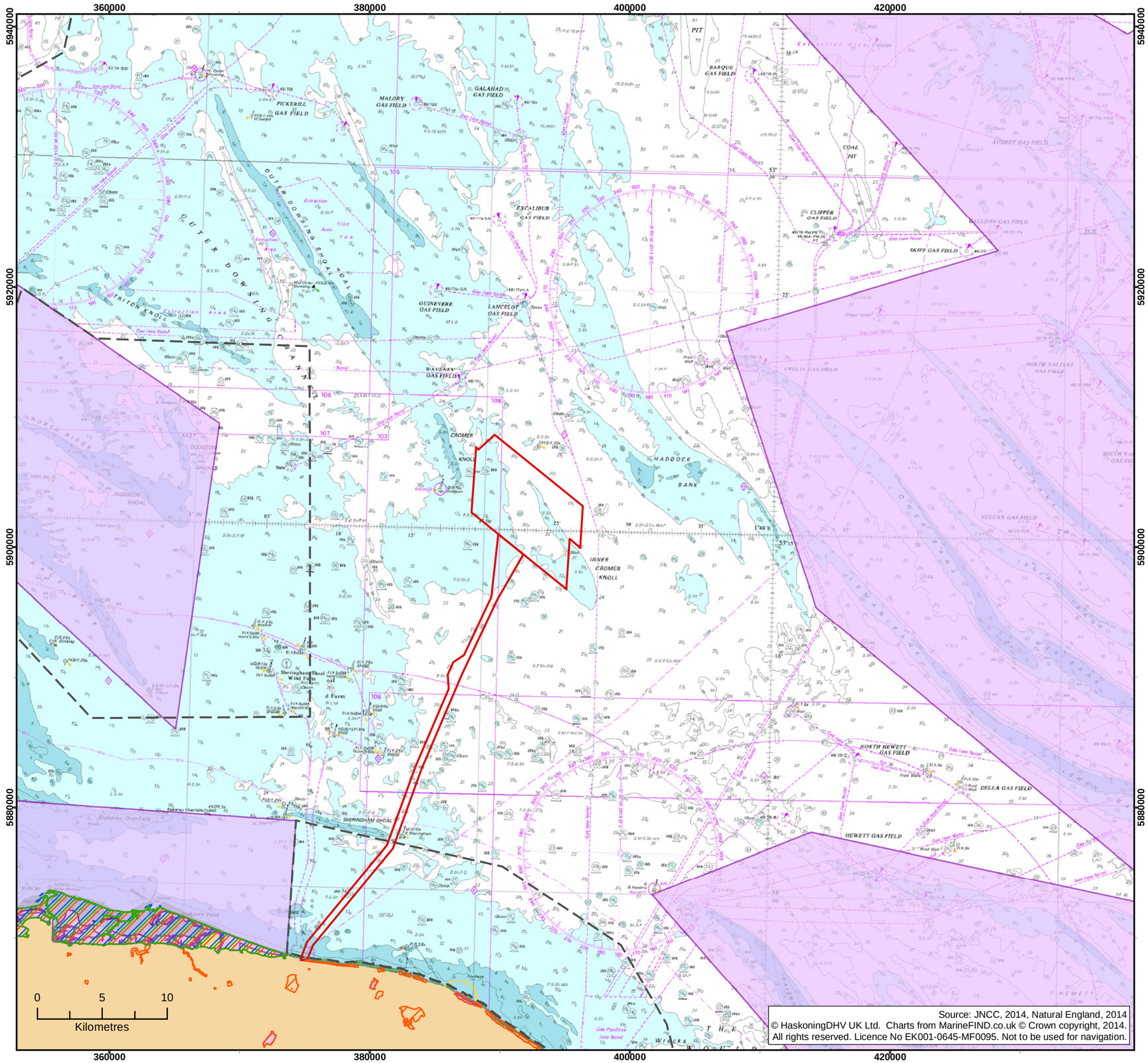
Name	Designation	Distance
International Designations		
North Norfolk Coast	Ramsar site	35.3km
The Wash		62.8km
Gibraltar Point		66.6km
Humber Estuary		71.2km
North Norfolk Coast SPA	Special Protection Area (SPA)	35.3km
The Wash SPA		62.8km
Gibraltar Point SPA		66.6km
Humber Estuary SPA		71.2km
Hornsea Mere SPA		119.25km
Flamborough Head and Bempton Cliffs SPA		128.6km
The Wash and North Norfolk Coast	Special Areas of Conservation (SAC)	26.9km
North Norfolk Coast		35.3km
Saltfleetby – Theddlethorpe Dunes and Gibraltar point		66.2km
Humber Estuary		74km
North Norfolk Sandbanks and Saturn Reef	Candidate SAC (cSAC)	14.6km
Haisborough, Hammond and Winterton		24.3km
Inner Dowsing, Race Bank and North Ridge		19.8km
National Designations		
Kelling Heath	Sites of Special Scientific Interest (SSSI)	36.2km
North Norfolk Coast (this consists of two NNRs, Scolt Head and Holkham)		35.3km
Weybourne Cliffs		33km
Weybourne Town Pit		35.2km
Hunstanton Cliffs		64.7km
Humber Estuary		73.9km
Flamborough Head and Bempton Cliffs		128.6km
Hornsea Mere		119.25km

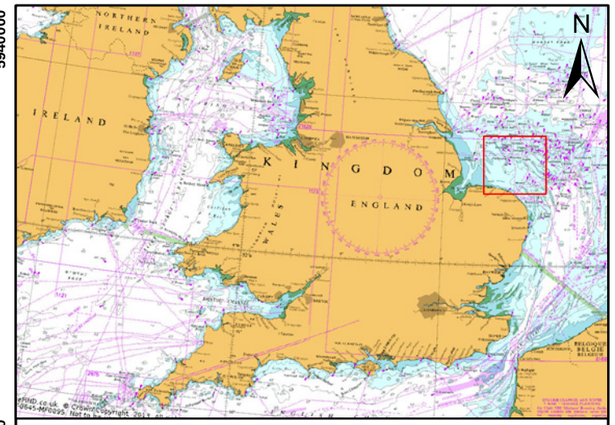
Non Statutory Designations

There are also a number of non-statutory designated sites within 2km of the cable landfall. These are:

- Norfolk Coast Area of Outstanding Natural Beauty (AONB);
- North Norfolk Heritage Coast;
- Beach Lane Country Wildlife Site (CWS);
- Kelling Hard CWS
- Kelling Heath Park and Hundred Acre Wood CWS; and
- Muckleburgh Hill CWS.

These sites can also be found on **Figure 3.6**.





Legend:

- Dudgeon Offshore Wind Farm & Export Cable Corridor
- Special Area of Conservation
- Special Protection Area
- Ramsar
- Site of Special Scientific Interest
- Marine Conservation Zone (recommended)

Client:	Project:
Dudgeon Offshore Wind Ltd	Dudgeon Offshore Wind Farm Preconstruction

Title:

Sites of nature conservation in the vicinity of DOW

Figure:	Drawing No:
3.5	PB2438-109-007

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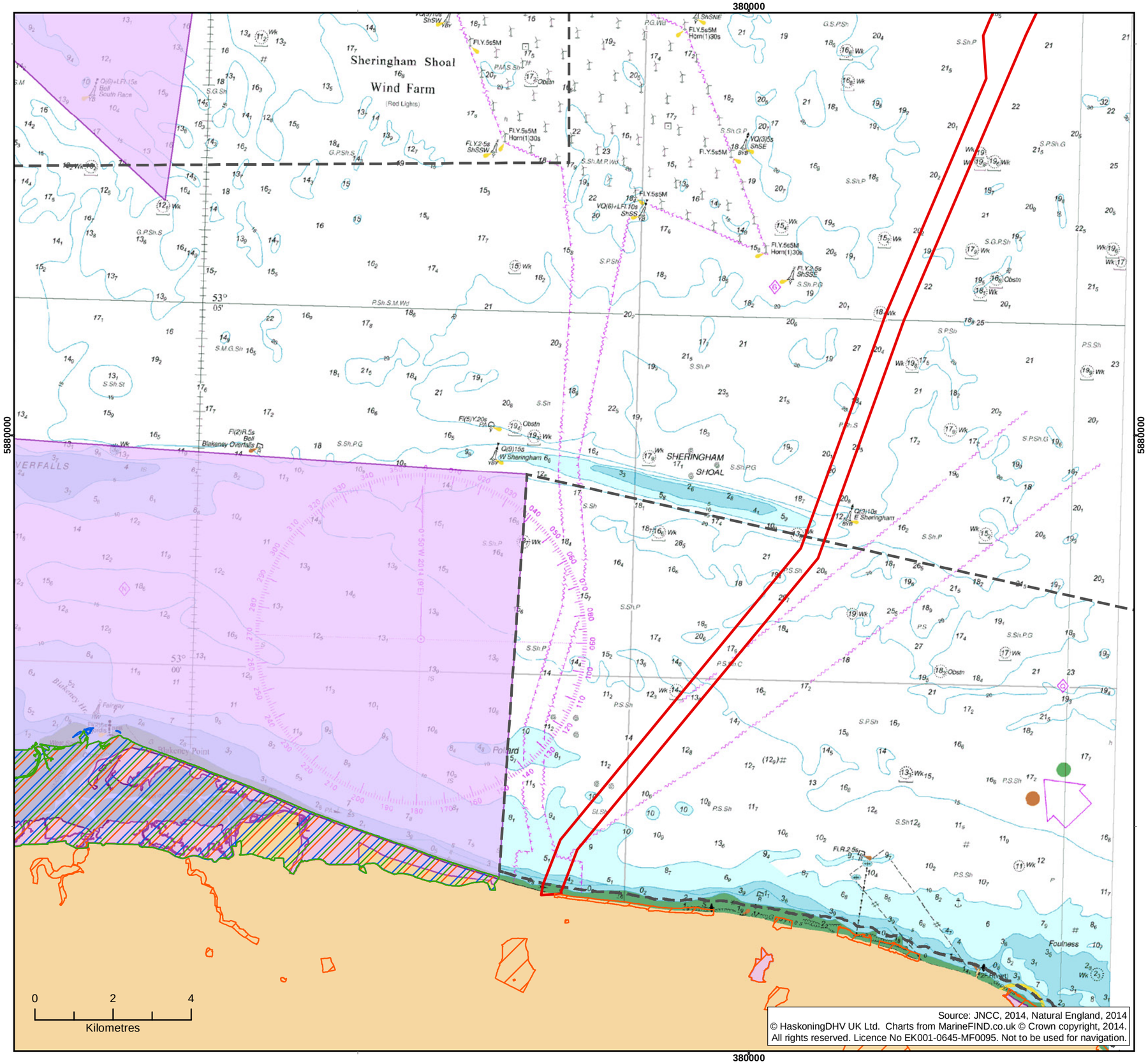

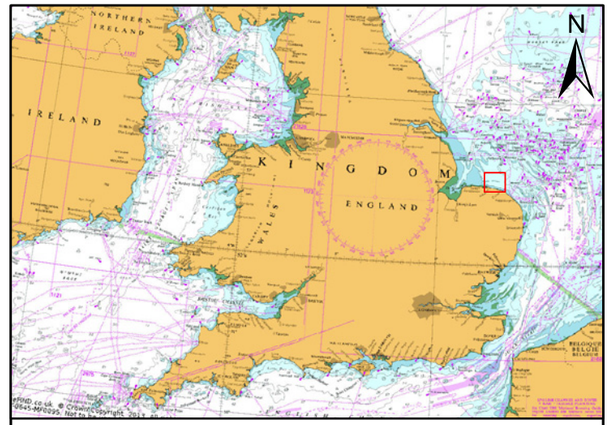

Legend:

- Dudgeon Export Cable Corridor
- Special Area of Conservation
- Special Protection Area
- Ramsar
- Site of Special Scientific Interest
- Marine Conservation Zone (recommended)

Client: Dudgeon Offshore Wind Ltd	Project: Dudgeon Offshore Wind Farm Preconstruction

Title: Nature conservation sites near the export cable corridor landfall

Figure: 3.6 | Drawing No: PB2438-109-008

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3.5 Site characteristics

3.5.1 Metocean characteristics

The metocean characteristics for DOW have been set out in **Table 3.4**.

Table 3.4 Metocean characteristics at the DOW site

Estimated average mean wind speed (predicted)	9.8m/s
Water depth range	18-25m below Chart Datum
Mean surface temperature	6°C (winter) / 17.5°C (summer)
Salinity	34.75 parts per thousand (PPT)

3.5.2 Topography& Bathymetry

The seabed is characterised by two regions of sandbanks with a flat region in between. Sandwaves are found over these sandbanks with crests running in a northeast-southwest direction. This indicates a predominantly northwest-southeast current direction. The area between these sandbanks is fairly flat with depths of about 20 – 22m below Lowest Astronomical Tide (LAT).

3.5.3 Currents and Tides

Tidal ranges vary across the area. **Table 3.5** shows the ranges at Weybourne Hope for the landfall site and at Cromer for the wind farm site as this site is most applicable to the wind farm location. Storm surges due to abnormal weather conditions may alter this tidal range. The maximum surge elevation expected once in 50 years is 2.50 – 2.75m.

Table 3.5 Predicted tidal ranges relevant to DOW

Sea level	Weybourne Hope mODN	Cromer mODN
MHWS	2.70	2.45
MHWN	1.45	1.35
MSL	0.05	0.05
MLWN	-0.80	-0.65
MLWS	-2.15	-1.95

Tidal flow across the DOW site is approximately rectilinear on a south east – north west axis. Peak speeds at mean spring tide range between 0.8 – 1m/s and at neap tides between 0.5 – 0.6m/s. Currents increase to the south of the site towards the coast. In this area they reach a peak of more than 1.1m/s before they reduce in speed closer to the shore. During storm surges these speeds may increase by up to 50% (HR Wallingford, 2002a).

3.5.4 Sea and swell

The wind farm site and export cable route are exposed to waves generated across the North Sea, but modified by the numerous sandbanks across the Greater Wash Strategic Environmental Assessment (SEA) area.

Winds from the south through north west are most frequent, but the fetch lengths from land to the wind farm site are relatively short and waves are small (significant wave height (Hs) generally less than 1m and rarely above 2m). North westerly through north easterly winds are less frequent, but are not fetch limited and therefore, generate the largest waves, which have the potential to exceed 10m (DOWL Environmental Statement, 2009).

3.5.5 Geological and geophysical characteristics

In support of the DOW EIA, the seabed sediments at and around the wind farm site and along the export cable route were sampled, and geophysical surveys were completed (Gardline Geosurvey, 2007, 2008). Information for the Dudgeon site, export cable route and coast was also derived from the Southern North Sea Sediment Transport Study (SNSSTS), JNCC publications, Admiralty Charts, British Geological Survey (BGS) publications and previous studies (HR Wallingford, 1994, 2002a , 2002b; JNCC , 1996; BGS, 1987).

The wind farm site mainly comprises a gently sloping bed deepening from about 17mCD in the west to about 24mCD in the east. The southern tip of the Cromer Knoll sandbank is located at the north west of the site, with minimum depths to 11mCD over the crests of large sand waves. The Inner Cromer Knoll sandbank is located across the south east of the site with minimum depths to about 10mCD over sand waves. The sand waves are generally in the region of 3m height but reach a maximum of up to 7m height and are assumed to be mobile over the time periods of interest to the project.

The mobile surface sediment of the study area comprises mainly superficial gravely fine to medium sand, believed to be derived from reworking of the late Pleistocene glacial till bed known as the Bolders Bank Formation. The two areas of sandbank and sand waves within the wind farm site comprise mainly sand with shells to a thickness of about 4m in the north and up to 12m in the south. The Bolders Bank Formation has a thickness of 4 – 10m and overlies Pleistocene heterogeneous sediment (sandstone, mudstone) of the Swarte Bank and Egmond Formation. The underlying bedrock is Cretaceous Chalk, which is exposed or near surface within about 5 – 19km of the shore. Chalk is also exposed at the low eroding coastal cliffs near the landfall.

The upper surface of the Chalk slopes down to the north, from surface exposure near the shore to a depth of at least 45m below the seabed at the wind farm site. Both the glacial till and the chalk surface are cut in places by channels and depressions, infilled by Holocene sand/gravel/clay/peat beds and covered by mobile surface sediments . An infill channel is found in the north western area of the wind farm site, with several more identified along the export cable route.

3.5.5.1 Landfall

The landfall area is subject to ongoing retreat as a result of cliff and nearshore seabed erosion along the coast and the landward migration of the shingle beach.

The coastal cliffs are most resistant where there is a base layer of chalk, but the chalk surface dips down to the east, leaving only the soft glacial cliffs. Historic map analysis indicates that cliff erosion rates along the north Norfolk coast vary from 0.3m/year up to as much as 2.0m/year, with an average of about 0.5m/year along the frontage from Weybourne Hope to Sheringham. The eroded material feeds littoral drift to the west and east depending on sea conditions and location.

4 Description of items to be decommissioned

4.1 Decommissioning options

DOWL have considered alternative options for the decommissioning of the wind farm site, a brief summary of the options is set out below. When making a decision on the best option prior to decommissioning DOWL will take into consideration the 'Best Practicable Environmental Option' along with commercial viability and HSE risks. The current option for the decommissioning of DOW involves the removal of the turbine structures and substation at the seabed, with export and interarray cables being left *in situ*. Further details on this can be found in Section 5.

4.1.1 Decommissioning and construction of a new wind farm

For this scenario the assumption has been made that wind energy is still economically attractive in 2042 and the technical integrity of the wind farm is declining. If this is the case it is likely that the profitability of installing new and better technology will be more beneficial than increasing the Operation and Maintenance (O&M) effort for a few extra years of running time. The existing wind farm would be decommissioned and a new wind farm erected.

4.1.2 Re-powering

In this scenario it is assumed that wind energy is still economically attractive in 2042, the technical integrity of the wind turbines is declining but the electrical infrastructure and possibly foundations are able to see out the lease period.

If electrical infrastructure is installed properly its lifetime is assumed to be able to last for the entire lease period (50 years). Experience from the oil and gas industry indicates that the lifetime of foundations can also be extended outside the design specifications. By closely monitoring the structural integrity of the asset, it could be possible to reuse these parts of the system in a re-powering of the wind farm.

4.1.3 Step-down

This scenario assumes it is not profitable to invest in new technology and most turbines will perform sufficiently after the design lifetime of 25 years. The wind farm would be decommissioned through a controlled step-down. In this case wind turbines would be gradually shut down as their technical integrity declines. Profitability would be weighed up against maintenance and repair costs A decommissioning campaign would most likely be done when the complete wind farm is shut down, but could also be done stepwise if found to be more cost effective or regulations required this approach.

4.2 Guiding principles

As part of the decommissioning plan, DOWL has sought solutions for all offshore components of the development that comply with the principles as set out in **Table 4.1**.

Table 4.1 Guiding principles for DOW

Guiding principles	Comments
Health and safety	DOWL is committed to adhering to the highest standards for health and safety throughout the lifecycle of the DOW project. DOWL seeks to promote safe practices and minimise risk in the development and implementation of decommissioning solutions.
Rights and needs of other legitimate marine users	DOWL respects the rights and needs of other users of the seabed. Decommissioning activities will seek to minimise the impact on stakeholders and emphasis will be placed on clear, open communication.
Minimise environmental impact	In considering decommissioning measures, the Best Practicable Environmental Option (BPEO), will be chosen in order to minimise impact on the environment at an acceptable cost.
Promote sustainable development	In decommissioning the DOW, DOWL will seek to ensure that, as far as is reasonably practicable, future generations do not suffer from a diminished environment or from a compromised ability to make use of marine resources.
Adhere to the Polluter Pays Principle	DOWL's decommissioning and waste management provisions acknowledge their responsibility to incur the costs associated with their impact on the environment.
Maximise the reuse of materials	DOWL is committed to maximising the reuse of waste materials and pays full regard to the 'waste hierarchy'.
Commercial Viability	In order that commercial viability is maintained, the BATNEEC (Best Available Technique not Entailing Excessive Cost) decommissioning solutions will be sought.
Practical Integrity	Solutions that are necessary to achieve one or more of the above objectives must be practicable.

4.3 Details of items for decommissioning

This section provides details of the items that will be decommissioned at the end of the windfarms lifetime. Section 5 sets out the procedure by which the decommissioning works will take place.

4.3.1 Turbines

The 67 wind turbines that will be installed at DOW will be Siemens 6MW turbines. The turbines will be tapered tubular steel towers with characteristics as set out in **Plate 1** below. There will be three blades attached to a nacelle housing the generator, gearbox and other operating equipment. The unit transformer will be located in the tower base (above the high tide level).

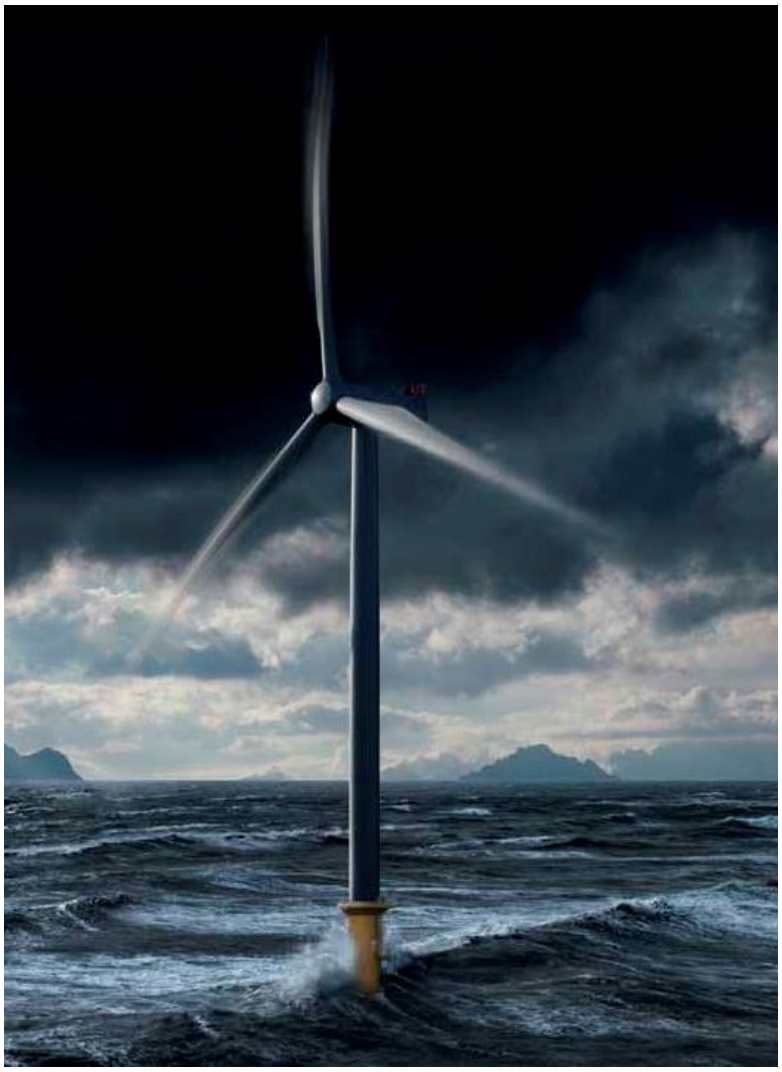

Plate 1 Offshore wind turbine

4.3.2 Foundations

Monopiles will be used for all wind turbine foundations and a suction bucket jacket foundation will be used for the DOW substation.

The monopiles will be installed either through pile driving or drilling. A hollow steel pile will be installed in to the seabed sub-strata using the following sequence:

1. Transport of foundation to offshore site;
2. Seabed preparation is carried out if required;
3. The installation vessel positions itself at the required location and holds its position;
4. Foundation is up-ended by the installation vessel into a vertical position and lowered onto the seabed;

5. Installation of monopiles progressed by piling or drilling or a combination as required by site specific soil conditions;
6. Installation of transition piece and any ancillary equipment; and
7. Installation of scour protection if required.

Plate 2 Monopile foundation

The monopile will rely on the frictional properties of the seabed sediments for support.

An access platform will form part of the foundation to enable access to the wind turbine at any state of the tide. It will comprise of two access ladders (with integral personnel safety protection).

The jacket foundation suction buckets will be installed following a similar sequence as used for drilled/piled monopiles as described above. Following the 4th step, the below sequence takes place instead of the above:

5. Suction buckets are fitted with pumps and control units;
6. Suction bucket lowered to seabed location, with structure weight providing initial seabed penetration;
7. Negative pressure is then applied within the bucket structure by means of the pumps and it is embedded until the top sits as close as possible to the seabed; and

8. A layer of grout will be pumped into the top of the bucket after installation, to provide a uniform bearing surface between the top of the suction bucket and the seabed.

4.3.3 Substation

To transform the voltage of the electricity generated by the wind turbines in to a suitable voltage for transmission, a substation is required. DOW will utilise one such substation for the site. The substation is likely to have dimensions of approximately 40m length, 21.5m width and 37.5m height. The highest point will be approximately 44.6m above LAT.

Plate 3 Offshore substation

4.3.4 Inter-array cables

To transfer the power generated by the wind turbines to the substation, DOW will use 33kV inter array cables. These cables will be buried to a depth of approximately 1m in accordance with safety requirements.

4.3.5 Export cables

To transfer the power produced by the wind farm to shore, DOW will have two 132kV HVAC export cables coming to shore north of Weybourne. These cables will be buried to a depth of approximately 1m in accordance with safety requirements.

5 Proposed Decommissioning Measures

The scope of the proposed decommissioning operation is limited to the removal of the WTGs with piled foundations. The export cable and substations will be the property of the OFTO, and therefore DOW will not be responsible for the decommissioning of these. The requirements to decommission the substation and export cables in an appropriate manner will be transferred to the OFTO, however a brief overview of the likely procedure is provided below for information.

For the purposes of this methodology assumptions have been made on the availability of specialist tools and the capacity of the vessels used for decommissioning. As DOW nears decommissioning, it is anticipated that decommissioning of wind farms will have become an industry in itself, with the tools and vessels altering from the current assumptions. Therefore, in the years prior to decommissioning of DOW, this methodology will be updated based on best practice at the time.

5.1 Method Statement

When determining the most appropriate method for decommissioning, DOWL have considered the following:

- Best practicable environmental option;
- Safety of surface and subsurface navigation;
- Other users of the sea;
- Health and safety considerations; and
- Costs.

The removal of the WTGs with foundations and substation installed on the DOW is planned to be performed in two stages:

- Stage 1 – Preparation of WTGs , WTG Foundations, Substation topside and jacket
- Stage 2 – Removal of WTG s, WTG Foundations, Substation topside and jacket

5.1.1 Stage 1 – Preparation of WTG and foundations

To achieve optimal use of the jack-up vessel preparation of WTG and foundation is performed prior to the removal. The preparation is performed using Personnel Transfer Vessels (PTVs) or a Service Operation Vessel (SOV).

Preparation of the WTGs will result in debris, items and fluids that will need to be cleared away from the unit before removal can commence during Stage 2. All debris created from this stage in the process will be stored in the WTG in containers until Stage 2. The containers will then be moved to the jack-up vessel before the lifting operations begin. This is to remove the HSE risk created if the containers were transferred from WTG to a PTV.

It is estimated that a five man crew will need six days to finish the work tasks presented in **Table 5.1**. For the preparation of 67 turbines this will result in a workload of 2010 active man days. The actual duration will

depend on the number of technicians that is assigned to the task and the weather windows available during decommissioning.

Table 5.1 Work tasks to be performed during Stage 1

Task	Task
1	Clearing of loose items in WTG nacelle and tower.
2	Installation of temporary lighting in WTG tower and nacelle
3	Cutting of wiring at separation points between WTG nacelle and tower, tower sections and at cutting points in TP
4	Preparation of bolts on rotor blades and tower flanges. Cleaning and application of penetrating oil to help the disassembly.
5	Preparation of temporary power supply for high speed motor to turn rotor. Cabling from nacelle to the base of the tower, the motor will be powered from the jack-up for the removal operation.
6	Installation of ventilation system below airtight platform. The void space below the airtight platform is designed to be oxygen free to prevent corrosion inside the MP (Monopile). Because work will be performed below this platform during the removal this space must be ventilated before the removal.
7	Removal of elevator from tower. The elevator in the tower will be parked at the base of the tower and the steel wires, power cables and additional systems are dismantled and stored at the base of the tower

5.1.2 Stage 2 – Removal of structures

5.1.2.1 WTGs

Removal of the WTG structures is the most comprehensive task of the decommissioning process. A jack-up vessel is most likely to be required. Current assumptions on what will be available when DOW reaches decommissioning lean towards bigger vessels with larger capacities and robust weather limitation.

Removal of the WTGs will be carried out using a reversed installation method where tools such as angle grinders and plasma cutters are used to remove bolts that it is not possible to remove using normal methods. Plasma cutters are used in place of acetylene torches to remove the need for combustible gasses and the accompanying HSE risk.

5.1.2.2 WTG Foundations and Substation

The method for removal of foundations is dependent on the type of foundation used. As detailed above, DOW will be using monopile foundations for all WTGs and a jacket foundation with suction buckets for the substation. Details are provided below on removing both types of foundations.

WTG Foundations (Monopiles)

After removal of the WTG, rigging is prepared to lift the top of the transition piece. Cutting is started while the crane supports the load above the cut. With the top piece of the transition piece removed, internal access to the lower end of the monopile is possible. An Internal Cutting Manipulator (ICM) is used to release the external J-tubes and cut the monopile at the seabed level. The scour protection will remain as installed during the wind farm construction phases.

ICMs use abrasive water jet (AWJ) cutting to cut piles for Oil and Gas platform removal. Currently these tools are used to cut piles with a diameter of up to three meters. It is assumed that a cutting tool based on AWJ technology capable of cutting the monopile will be available on the market by the time DOW is decommissioned.

At the time of decommissioning consideration will be given to the environmental impact of the chosen cutting tool, and the requirement for an assessment of any predicted impacts e.g. noise/disturbance impacts to determine any mitigation that maybe required.

Substation topside and jacket

It is proposed that the oil/resin filled transformers are sealed and removed separately and taken to shore complete, reducing the potential for offshore spillage risk and facilitating safe dismantling. Next the topside will be lifted from the jacket foundation and removed in one piece. The jacket legs will be cut at the top of the bucket, leaving approximately 2.5m of the bucket above the level of the seabed. It is assumed that J-tubes will not have to be removed from the jacket and that only the power cables will have to be cut (see Section 5.1.2.3 for details on power cables). Given the structure of the bucket there may be a requirement for some rock placement once the jacket has been cut. The requirement for this will be dependent on the state of the existing scour protection and any accumulation of sand/silt during the development. This will be reviewed when the detailed design of decommissioning is determined.

5.1.2.3 Inter-array and export cables

It is assumed that inter-array and export cables will be left in-situ following decommissioning. As these will be buried to a safe depth for the operational stage of DOW, leaving the cables buried will not pose any additional navigational risks. The minimum burial depth for the infrastructure remaining in situ will be 1m as per the construction methodology. Any exposed cables will be cut and removed.

Once the wind farm is operational, further surveys will be undertaken to ensure cables are buried sufficiently. The results of the initial survey will determine the requirement for any further surveys. The results of these will inform the need for a cable burial assessment to identify any exposed cables prior to decommissioning.

In areas where cable protection has been required during the operation of the wind farm, consideration will be given to the best approach for decommissioning. This will be determined based on the principles set out in Section 5.1.

5.1.2.4 Scour protection

The removal of scour protection will be investigated in the lead up to decommissioning to determine the best environmental option and what technology is available at the time.

For all the structure removals set out in Section 5.1.2, it should be noted that a Marine Pollution Contingency Plan will be produced if required. Furthermore, consideration will be given in the EIA to the leaking of heavy metals and other pollution impacts related to leaving infrastructure *in situ*.

5.1.3 Stage 3 – Protection of remaining structures, completion and third party inspection

It may be necessary to protect the remaining structures at the substation location. This would be performed after removal of the structures. This will only take place if deemed necessary, after all other options have been exhausted, and would involve the most appropriate protection method at the time of decommissioning.

Third party inspection at each site will be undertaken to provide documentation that the removal has been undertaken to a satisfactory level. For the inspection a PSV with an observation ROV will be necessary.

5.2 Management of waste

DOWL commit to following the principles of the waste hierarchy during decommission of DOW, along with all relevant legislation at the time.

For recycling of the WTGs and foundations the Teesside Environmental Reclamation and Recycling Centre (TERRC) facility in Hartlepool used as a base case. The transit distance from DOW to Hartlepool is about 135nm and the harbour has the necessary facilities to accommodate for the jack-up vessels while un-loading.

5.3 Navigation and Lighting

In accordance with the DOW consent under Section 36 of the Electricity Act 1989, DOWL is committed to exhibiting the appropriate marking and lighting during construction, operation and decommissioning of the wind farm. As such a lighting and marking plan has been agreed between DOWL, Trinity House and the MCA for the construction and operational stages of the project. This includes the placement of a cardinal buoy at the south eastern corner of the site to ensure safe navigation around the site.

The Civil Aviation Authority (CAA) has also given their approval for the shape, colour and character of lighting for aviation safety.

Prior to decommissioning, the lighting and marking requirements will be agreed with Trinity House, the MCA and CAA. In the event that any obstruction is left on site that may be considered to be a hazard to navigation, DOWL will liaise with Trinity House to ensure it is marked in accordance with their requirements.

6 Environmental Impact Assessment

The existing ES and SEI for DOW considered the impacts of decommissioning. In most cases the impacts identified were similar in nature to those associated with the construction stage although in general they will be of a shorter duration and magnitude.

Consistent with the commitment to undertake reviews of the decommissioning programme, DOWL propose that the existing ES and SEI will be reviewed and updated prior to decommissioning occurring. Surveys may be undertaken to help inform this process, which could include:

- Geophysical:
- Benthic;
- Ornithological, a single year survey to identify any species that could be susceptible to disturbance and if there are any particularly sensitive times of the year;
- Review of nature designations;
- Marine Mammals, if decommissioning activity is likely to give rise to high noise levels. However, it is anticipated that this will not be the case;
- Other sea users, e.g. shipping routes, fishermen; and
- Impacts on archaeology and heritage.

These surveys are likely to take place a year prior to decommissioning and will inform any assessment undertaken. Results from the surveys will be provided to relevant bodies allowing sufficient time for consultation to take place (unless agreed otherwise in consultation with regulators and SNCBs).

Based on the results of any surveys that may be undertaken, a decision will be made on how detailed an assessment is required. This will be based on the final decommissioning methodology and identification and assessment of potential impact on the environment. Consultation with key stakeholders will occur to determine the level of detail required in the environmental assessment prior to decommissioning.

7 Consultation with interested parties

DOWL regards consultation with stakeholders as an essential element to the successful development of the project. Through the development of the project, from the initial Environmental Assessment, to the Supplementary Environmental Information and now during post-consent, the principle of open consultation and transparency of information has been followed. DOWL intend to continue with this approach for the lifetime of the project including the decommissioning phase.

DOWL will seek the opinions of the following organisations (or their equivalent) in drafting and reviewing the decommissioning programme prior to decommissioning:

- Natural England;
- Cefas;
- Marine Management Organisation;
- Environment Agency;
- Historic England;
- Eastern Inshore Fisheries and Conservation Authority;
- Trinity House;
- Maritime and Coastguard Agency;
- British Chamber of Shipping;
- RYA;
- NFFO; and
- BMAPA.

Consultation will be undertaken in the years preceding decommissioning on both the programme and any environmental assessment undertaken, in order to minimise the impact on the environment and stakeholders.

8 Costs & Financial Security

All required financial information has been provided in Annex 1 CONFIDENTIAL Dudgeon Offshore Wind Farm Financial Security Information. Please see this document for the relevant information.

9 Schedule

A full decommissioning schedule will be provided in due course. At this moment in time only an indicative decommissioning schedule is available (**Figure 9.1**).

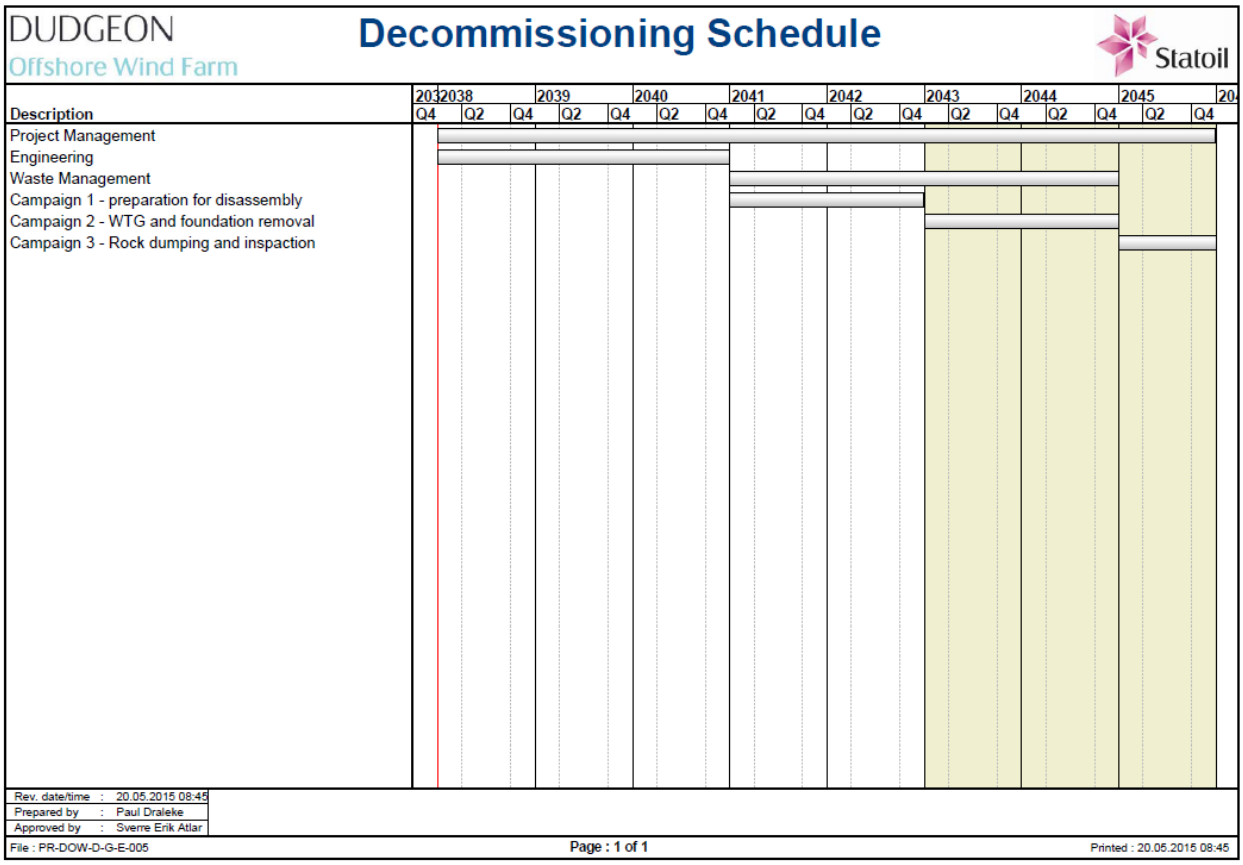

Figure 9.1 Indicative decommissioning schedule

10 Project management and verification

This section will be provided towards the final stages of the project, when an updated Decommissioning Programme is provided and consulted on based on the final decommissioning options.

11 Sea-bed clearance

In line with the details provided above, DOWL is committed to covering the costs required to decommission DOW (in line with the Polluter Pays Principle) and ensuring the seabed has been cleared. Upon completion of decommissioning, a survey will be undertaken to ensure that all debris has been removed, where required. The survey will enable identification and recovery of any debris located on the seabed which may have arisen from activities related to DOW and which may pose a risk to navigation.

The required survey area would be determined during the decommissioning phase of the project, taking into account best practice at the time and the views of stakeholders. It is anticipated that the survey area would focus around the renewable energy installation i.e. monopile and substation locations as it is assumed that inter-array and export cables will be left *in-situ*. DOWL is aware of the guidance for oil and gas installation which specifies a 500m radius around any installation, however, due to the smaller scale of the installations DOWL proposes a smaller radius could be used e.g. 100m.

Discussions would also occur on the requirement for independent, third party involvement in the surveys to provide evidence that the site had been cleared. It is likely that an independent party would conduct the surveys and provide an independent report on the findings.

12 Restoration of the Site

The wind farm site will be restored, as far as is practical to its pre-construction state. This will be achieved by removal of the monopiles to the seabed level, removal of the substation topside and jacket, ensuring adequate burial of all cables and leaving the suction bucket foundations *in situ* flush with the scour protection installed during the construction phase.

Further details on how the site will be restored will be provided in the updated Decommissioning Programme towards the end of the project's life.

13 Post-decommissioning Monitoring, Maintenance and Management of the Site

As DOWL is not proposing to fully remove all installations, some post decommissioning activities may be required to identify and mitigate any unexpected risks to navigation or other users of the sea. This could be due to the foundations or cables becoming exposed through natural sediment movement. The level of post decommissioning activities will be determined based on the scale of the remaining infrastructure, the risk of exposure, the risk to marine users and any surveys undertaken. It is likely that these will focus on the cables and foundations below the seabed as these will remain *in situ* following decommissioning.

Details of the post-decommissioning monitoring, maintenance and management will be discussed and agreed with stakeholders during decommissioning. Any outcomes from the results of monitoring and maintenance work will be provided to DECC and relevant stakeholders once available.

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