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Vattenfall Wind Power Ltd

Thanet Extension Offshore Wind Farm

Shadow EPS License Assessment

June, 2018, Revision A

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June, 2018

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Date of Approval	June 2018
Revision	A

SMRU Consulting

understand ♦ assess ♦ mitigate

Thanet Extension – Shadow EPS License Assessment

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1 Introduction

This document details the information required in support of an anticipated future application for a European Protected Species (EPS) licence, which may be required during the construction of Thanet Extension, should construction activity be expected to cause disturbance or injury to a European Protected Species. The three key marine mammal species identified as present in the Thanet Extension area were the harbour porpoise, the harbour seal and the grey seal, however of these, only the harbour porpoise is categorised as a European Protected Species. The worst-case activities under consideration for the Thanet Extension, during which harbour porpoise are predicted to be impacted, are percussive pile driving of monopile and jacket foundations.

1.1 European Protected Species Legislation

All cetaceans in Northern European waters are listed under Annex IV of the EU Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (the Habitats Directive) as European Protected Species (EPS) of Community Interest and in need of strict protection.

The Habitats Directive is transposed through the Conservation of Habitats and Species Regulations 2010 (in relation to reserved matters) and the 1994 Regulations. The Conservation (Natural Habitats, &c.) Regulations (1994, as amended in 2007) implement the Habitats Directives in territorial waters out to 12 nautical miles (nm). The Offshore Marine Conservation (Natural Habitats &c.) Regulations 2007 (as amended) (the Offshore Marine Regulations) transpose the provisions of the Habitats Directive in offshore waters, beyond 12 nm. The Habitat Regulations provide protection for designated sites, known as Natura 2000 sites which include SACs and Special Protection Areas.

The Habitats Regulations and the Offshore Marine Regulations make it an offence to injure or disturb any EPS. Any incidence of disturbance would be considered an offence if the disturbance is likely to have an ecologically significant adverse effect on a significant number of animals. The second element is that the disturbance must be likely to significantly affect the local distribution or abundance of the species. A disturbance offence would be committed if either of these elements occurred.

1.1.1 Guidance

The Joint Nature Conservation Committee (JNCC) published guidance in 2008 which defines deliberate disturbance and the circumstances in which an EPS licence is required (JNCC 2008). This was subsequently revised in 2010 by the JNCC, Natural England and the Countryside Council for Wales

(now Natural Resources Wales) (JNCC et al. 2010). The revised document outlines a preventative approach to ensure the strict protection of EPS in their natural range as required by Article 12 of the Habitats Directive. It provides an interpretation of the offences of deliberate capture, injury, killing or disturbance of any wild animal of an EPS, under regulations 41(1)(a) and (b) in The Conservation of Habitats and Species Regulations 2010 and 39(1)(a) and (b) in The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (amended in 2009 and 2010).

The guidance states that "*a permanent shift in the hearing thresholds (PTS) of an EPS would constitute an injury offence*" and that "*the risk of an injury offence will be higher in areas where EPS occur frequently and/or in high densities*" (JNCC et al. 2010).

Guidance is provided on how to determine what constitutes a '*deliberate disturbance*', a '*significant*' effect on the ability of the species to survive, breed, or rear/ nurture their young, what is a '*significant*' group of animals and what are considered to be '*significant*' effects on the distribution and abundance of a species.

What constitutes a significant number of animals depends on the species, its population size, local abundance, its Favourable Conservation Status (FCS), the behaviour of the species and the circumstances in which the disturbance might take place (i.e. time of year, and the spatial and temporal range of the impact). For a significant effect on the local distribution or abundance of a species to occur, disturbance would need to produce more than a transient effect and result in a detrimental change from the natural variability in the spatial-temporal distribution and abundance of the species and its populations within their natural range. This would occur, for example, if a significant group of animals of a population were to become displaced, either from an area which they are known to persistently use or from a fraction of their natural range, for long periods of time; particularly if animals are displaced from essential habitats to less suitable ones.

1.1.2 EPS License

If the risk of injury or significant disturbance cannot be reduced to negligible levels with mitigation, then an EPS licence is required. In England, offshore EPS licencing is managed by the MMO. Licenses are granted if:

1) the reason for the license relates to one of the specified purposes listed in Regulation 53(2)(e) of the Conservation of Habitats and Species Regulations 2010 or Regulation 55(6)(a) of the Conservation of Offshore Marine Habitats and Species Regulations 2017,

2) there is no satisfactory alternative way to reduce injury or disturbance risk (Conservation of Habitats and Species Regulation 53(9)(a)) (Conservation of Offshore Marine Habitats and Species Regulation 55(9)(b)), and

3) the action authorised must not be detrimental to the maintenance of the population of the species concerned at a FCS in their natural range (Conservation of Habitats and Species Regulation 53(9)(b)) (Conservation of Offshore Marine Habitats and Species Regulation 55(9)(c)).

1.1.3 Favourable Conservation Status

The aims of the Habitats Directive are fulfilled by contributing to the *maintenance or restoration at favourable conservation status, of the populations of the species concerned in their natural range, while taking into account economic, social and cultural requirements and regional and local characteristics*. In order to assess whether a disturbance could be considered non-trivial in relation to the objectives of the Habitats Directive, consideration is given to the definition of the favourable conservation status (FCS) of a species. There are three parameters that are used to determine if the conservation status of a species is favourable:

1) Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable element of its natural habitats,

2) The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and

3) There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

1.1.4 Thanet Extension

The only EPS of interest with regards to Thanet Extension is the harbour porpoise (*Phocoena phocoena*).

2 Harbour Porpoise Baseline

2.1 Population Size

Thanet Extension is located within the North Sea MU for harbour porpoise (IAMMWG 2015), which is estimated to have an abundance of 227,298 porpoise (95% CI: 176,360 – 292,948) based on estimates from Hammond *et al*. (2013). The modelling conducted on the SCANS II data have since been revised using a point independence model which is less likely to result in a negatively biased abundance estimate. The revised harbour porpoise abundance for the North Sea using the SCANS III data was 355,000 (CV: 0.22) (Hammond *et al*. 2017) which suggests that the IAMMWG (2015) MU abundance data should therefore be considered out of date and not applicable.

Based on the SCANS III data, the estimated abundance of harbour porpoise in the ICES North Sea Assessment Unit is 345,373 (95% CI: 246,526 – 495,752) with an estimated density of 0.52 porpoise/km^2. The trend analysis conducted as of estimates in the North Sea and the Skagerrak/Kattegat/Belt Seas show no support for changes in harbour porpoise abundance since 1994 (Hammond *et al*. 2017).

2.2 Local Density

2.2.1 SCANS III

The aerial survey data collected in survey block L for SCANS III produced an estimated harbour porpoise abundance of 19,064 (95% CI: 6,933 – 65,703) and a density of 0.607 porpoise/km^2 (Hammond *et al*. 2017). These SCANS III density values were taken forward for Thanet Extension impact assessment as they are: a) the most recent of the SCANS survey density estimates and are therefore most likely to represent the current porpoise densities in the area; and b) the density is estimated for a smaller survey block than in previous SCANS surveys which makes it more applicable to the Thanet Extension area than previous survey blocks which estimated the density over a much wider area. However, it should be noted that the SCANS III data are for a single summer time point estimate and may not be representative of harbour porpoise abundance and density at other times of

the year. Therefore, the SCANS III data were presented in the impact assessment alongside the results of the APEM Thanet Extension site specific survey to provide a range of estimates.

2.2.2 Thanet Extension Aerial Surveys

During the 24 months of aerial surveys conducted across the Thanet Extension survey area, a total of 47 harbour porpoise have been identified from the still images collected by APEM (Table 7.7). A further 235 sightings of small cetaceans of insufficient quality to identify to species were also recorded during these surveys (Table 7.7). When these two datasets are combined then there is an apparent seasonal pattern to the sightings data, where sightings are highest in late winter/ early spring. While sightings were highest in February and March 2017, the survey in February 2017 was one of only two surveys to be conducted in sea state one (ripples in water). Harbour porpoise are notoriously difficult to detect during visual surveys due to their small size and inconspicuous surfacing behaviours. The detection probabilities for cryptic species, such as the harbour porpoise, are estimated to decrease with increasing sea state leading to most harbour porpoise visual studies to be restricted to sea conditions up to a maximum of sea state two (small wavelets that do not break). Although most studies of the effect of sea state on harbour porpoise detectability have been carried out in relation to boat-based visual surveys, it is also likely that sea conditions may affect harbour porpoise detectability during aerial surveys, although perhaps to a lesser extent when sighting conditions allow the detection of non-surfacing animals.

There is a spatial pattern in the sightings of combined harbour porpoise and unidentified small cetaceans. The sightings in the summer months were loosely clustered in the north-east part of the survey area, while in the winter months there is a concentration of sightings in the south-eastern part of the survey area (Figure 1).

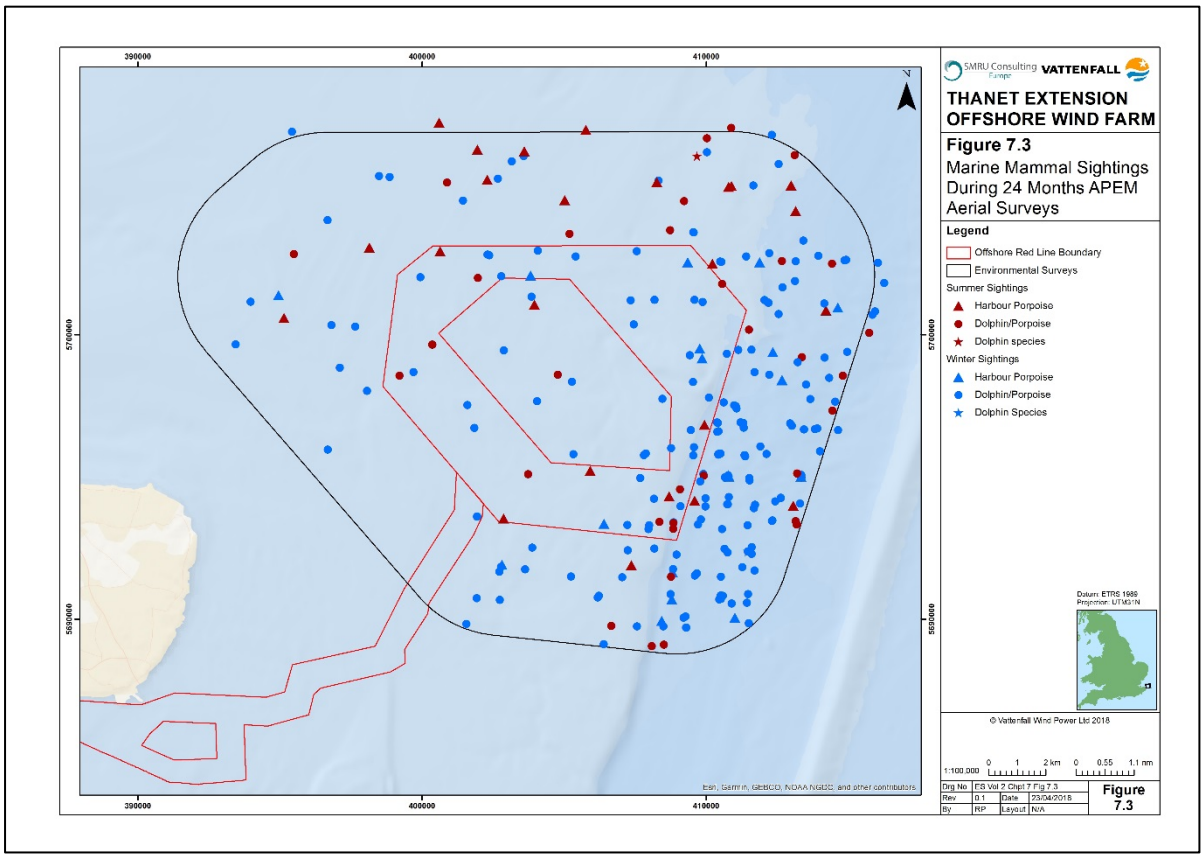

Figure 1 Sightings of harbour porpoise and dolphin/porpoise during the 24 months of APEM Thanet Extension aerial surveys. Summer = Apr-Sep, Winter = Oct-Mar.

Porpoise abundance was estimated by dividing the raw counts by the number of images taken to provide a mean number of porpoise per image. This was then multiplied by the total number of images required for the survey area. The resulting abundance and density estimates are provided in Table 1. A report produced by APEM (Voet *et al*. 2017) provides a correction factor to account for availability bias in aerial digital still surveys. This correction factor assumes that the top 2 m of water are visible in the digital still images and uses animal-borne telemetry data from Teilmann *et al*. (2007) and Teilmann *et al*. (2013) on the proportion of time that harbour porpoise spend in the top two meters of the water column. The abundance estimate is then adjusted by this correction factor to account for animals below two meters water depth that are not available for detection at the time of the survey.

The corrected abundance and density data are presented in Table 1. The existing data available in the literature and from site-specific surveys at nearby OWF show that no species of dolphin is common in the greater Thames Estuary area; therefore, it is unlikely that these unidentified small cetacean sightings are dolphin species. Therefore, the same correction factor was applied to the unidentified

small cetacean sightings, densities were calculated based on a survey area of 345 km^2 and combined with the harbour porpoise data (Table 1). These data present corrected densities of up to 4.11 combined porpoise/dolphins per km^2 in February 2017 and 3.21 combined porpoise/dolphin per km^2 in March 2017, with much lower densities throughout the rest of the year (mean of 0.61 combined porpoise/dolphins per km^2, Table 1).

The mean density estimated from the Thanet Extension aerial surveys (0.610 combined porpoise/dolphins per km^2) is fractionally higher than the SCANS III Block L estimate of 0.607 porpoise/km^2. The resulting mean site specific survey estimates (plus minimum and maximum density in the absence of confidence intervals) were used in the marine mammal impact assessment alongside mean density estimates from the SCANS III survey (plus 95% Confidence Intervals). This was agreed with the Offshore Ecology Technical Expert Panel.

Table 1 Abundance and density estimates for the sightings of "harbour porpoise" combined with the additional "dolphin/porpoise" sightings before and after correcting for availability bias (Voet *et al*. 2017).

	Abundance	Density (#/km^2)	Correction Factor	Corrected Abundance	Corrected Density (#/km^2)	Sea State
	Combined Porpoise and Dolphin/Porpoise					
Mar-16	85	0.25	0.571	149	0.43	2
Apr-16	123	0.36	0.571	215	0.62	2
May-16	0	0.00	0.571	0	0.00	2
Jun-16	25	0.07	0.547	46	0.13	1-3
Jul-16	43	0.12	0.547	79	0.23	2
Aug-16	33	0.10	0.547	60	0.17	1-3
Sep-16	9	0.03	0.455	20	0.06	2-3
Oct-16	8	0.02	0.455	18	0.05	3
Nov-16	53	0.15	0.455	116	0.34	3-4
Dec-16	36	0.10	0.472	76	0.22	3
Jan-17	34	0.10	0.472	72	0.21	3
Feb-17	671	1.94	0.472	1422	4.11	1
Mar-17	633	1.83	0.571	1109	3.21	1-4
Apr-17	47	0.14	0.571	82	0.24	1-2
May-17	9	0.03	0.571	16	0.05	1
Jun-17	94	0.27	0.547	172	0.50	2-3
Jul-17	0	0.00	0.547	0	0.00	3-4
Aug-17	66	0.19	0.547	121	0.35	2-3
Sep-17	9	0.03	0.455	20	0.06	2-3
Oct-17	38	0.11	0.455	84	0.24	3-4
Nov-17	28	0.08	0.455	62	0.18	2-3
Dec-17	9	0.03	0.472	19	0.06	3
Jan-18	285	0.82	0.472	604	1.75	
Feb-18	236	0.68	0.472	500	1.45	
			Min	**0**	**0.00**	
			Mean	**211**	**0.61**	
			Max	**1,422**	**4.11**	

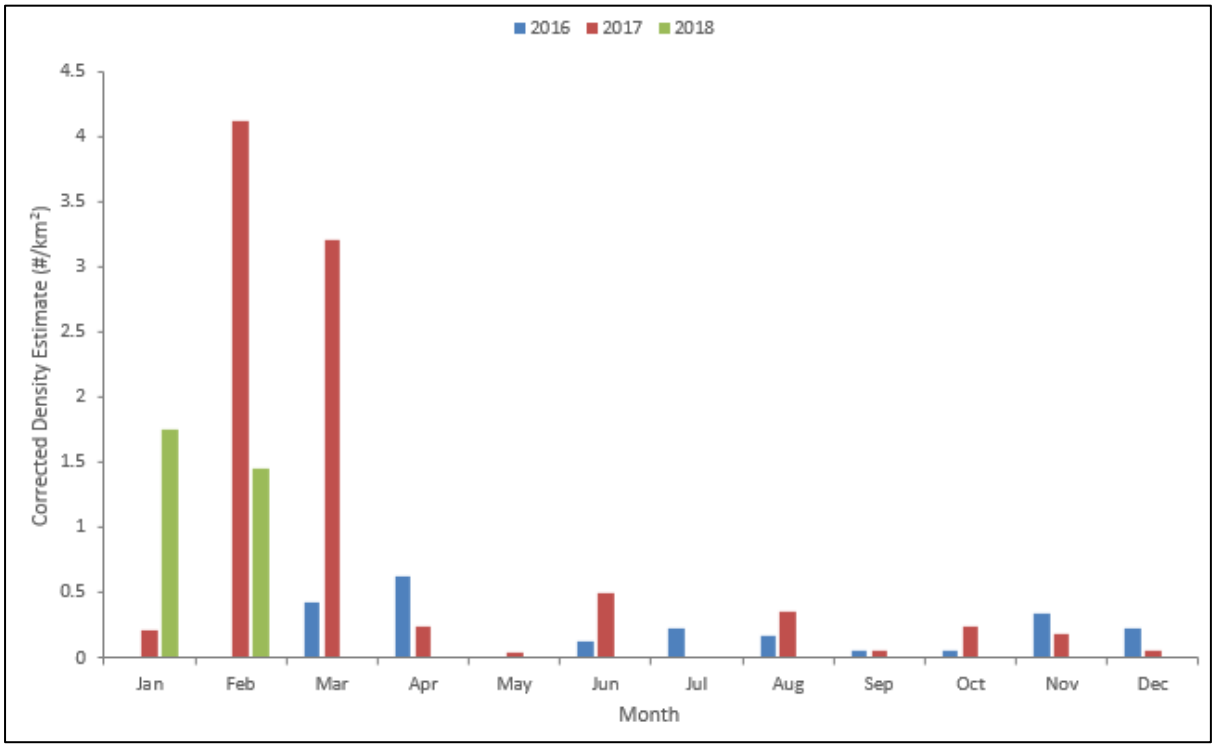

Figure 2 Corrected density estimates for combined "harbour porpoise" and "dolphin/porpoise" by survey month between March 2016 and February 2018.

3 Species Favourable Conservation Status

3.1 Harbour porpoise

The conservation status of harbour porpoise was last assessed by the UK in 2013 (JNCC 2013). The assessment considered the species range, the population size, the available habitat for the species and the future prospects for the population and concluded that harbour porpoise in the UK have a Favourable conservation status.

In addition to this, the data from the SCANS III survey mean that there are now three estimates of harbour porpoise abundance for the North Sea from SCANS I, SCANS III and SCANS III, which allowed the investigation of population trends over time. The SCANS abundance estimates show that the North Sea harbour porpoise population has shown no change in abundance since 1994 (Hammond et al. 2017) (Figure 3). This is therefore considered to be a stable population.

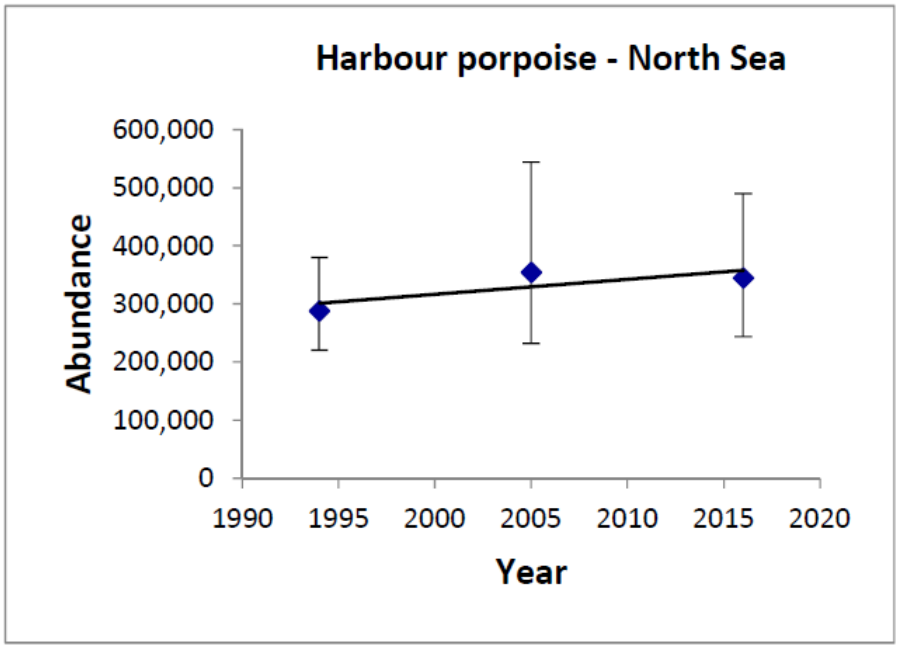

Figure 3 Trends in abundance for the North Sea harbour porpoise population over the three SCANS surveys (Hammond et al. 2017).

4 Noise Impact Assessment Thresholds

It is an offence to deliberately kill, injure or disturb an EPS species, therefore this assessment includes the prediction of the ranges at which physical injury (auditory (PTS) physical injury) and disturbance effects could occur. The following sections outline the thresholds used to assess potential injury and disturbance impacts.

4.1.1 PTS

The EPS guidance provided by JNCC et al. (2010) outlines the PTS thresholds that should be applied for cetacean species based on Southall et al. (2007). However, the Southall et al. (2007) have since been largely superseded by the National Marine Fisheries Service (2016) Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts (PTS and TTS). The US National Oceanographic and Atmospheric Administration (NOAA) Fisheries has compiled, interpreted, and synthesized the best available science to produce updated acoustic thresholds for the onset of auditory injury. The acoustic thresholds in this document identify the levels of sound, which after they are exceeded, NOAA anticipates (after evaluating and interpreting all available science) changes in auditory sensitivity (temporary or permanent threshold shift). It was agreed in consultation with

Natural England and CEFAS that the PTS and TTS thresholds presented in National Marine Fisheries Service (2016) should be used in the Thanet Extension impact assessment for marine mammals instead of the Southall et al. (2007) thresholds.

4.1.2 Disturbance

Unlike for thresholds of auditory injury, there are currently no established regulatory guidance documents and few published scientific articles providing clear advice on the appropriate thresholds for behavioural response to pile-driving noise. Southall et al. (2007) defined a severity score to categorise the effect of sound on marine mammals, with scores of zero to three used to categorise relatively minor and/ or brief behavioural reactions, scores four to six for behavioural changes that have a higher potential to affect foraging, reproduction or survival, and scores seven to nine for changes that are considered to likely affect vital rates. For the assessment of the behavioural impact of piling, responses with severity scores four to six are likely to require assessment as any responses affecting individual reproduction or survival have the potential to result in population level consequences.

Behavioural responses to noise are highly variable and are dependent on a variety of internal and external factors. Internal factors include past experience, individual hearing sensitivity, activity patterns, motivational and behavioural state at the time of exposure. Demographic factors such as age, sex and presence of dependent offspring can also have an influence. Environmental factors include the habitat characteristics, presence of food, predators, proximity to shoreline or other features. Responses themselves can also be highly variable, from small changes in behaviour such as longer intervals between surfacing (Richardson 1995) or a cessation in vocalisation (Watkins 1986) to more dramatic escape responses (Götz and Janik 2016).

This variability makes it extremely difficult to predict the likelihood of responses to underwater noise from piling. Even where empirical data exist on responses of animals in one particular environment, the context related variability described above makes it difficult to extrapolate from one study to a new situation. It is important to note that all any impact assessment can do, is predict the *potential* for behavioural responses, as definitive predictions of likelihood or magnitude are particularly difficult.

In light of this, the Thanet Extension assessment adopted a two-fold approach: the first approach was to use a fixed threshold to determine the range at which animals might respond, similar to the way in which impact ranges for PTS are calculated. The fixed behavioural threshold for porpoise is based on

the study conducted by Lucke et al. (2009) which showed an aversive behavioural reaction in a captive porpoise to the stimuli at an SEL of 145 dB re 1 μPa^2s. The use of a fixed threshold assumes that all animals within the area of the threshold's calculated impact range display a behavioural reaction, while none of the animals outside this area will react. This is clearly biologically unrealistic. The proportion of animals responding will depend on the received sound level, which will decrease with increasing distance to the sound source. Therefore, a second approach was also adopted, using a dose-response curve. This approach is based on data suggesting that the proportion of animals responding depends on the loudness of the sound, with animals closer to the source, and therefore experiencing louder sounds, more likely to respond than those further away. For this approach, a series of noise contours were modelled and used to calculate the corresponding proportion of animals predicted to respond based on the dose-response curve.

It was agreed in consultation with Natural England and CEFAS that the assessment of disturbance for harbour porpoise should be based on both the fixed threshold approach (Lucke et al. 2009) and a dose-response approach using the harbour porpoise dose-response curve derived from Thompson et al. (2013).

5 EPS Assessment

5.1 Test 1: Imperative Reasons of Overriding Public Interest

Only activities carried out for certain purposes can be licensed. These purposes include '*imperative reasons of over-riding public interest including those of a social or economic nature and beneficial consequences for the environment*' and '*scientific and educational purposes*'.

As stated in the guidance provided by the European commission (European Commission 2007) on Article 6.4 of the Habitats Directive: Imperative reasons of overriding public interest (IROPI) refer to situations where plans or projects envisaged prove to be indispensable:

- within the framework of actions or policies aiming to protect fundamental values for the citizens' life (health, safety, environment),
- within the framework of fundamental policies for the State and the Society, and
- within the framework of carrying out activities of economic or social nature, fulfilling specific obligations of public service.

The ability of Thanet Extension to contribute to the UK energy targets is the basis on which the IROPI criteria are met. Thanet Extension comprises of offshore wind turbines with an overall capacity of greater than 100 MW and therefore classifies as a Nationally Significant Infrastructure Project (NSIP), as defined by Section 15(3) of the Planning Act 2008. The UK energy targets which Thanet Extension will contribute to are summarised below:

5.1.1 20-20-20 Targets

At a European level, the European Parliament and Council agreed a climate and energy package known as the 20-20-20 targets in 2008. The targets to be achieved by 2020 include the requirement that 20% of EU energy consumption to come from renewable energy sources. In order to meet these targets, the EU introduced Directive 2009/28/EC on the promotion of the use of energy from renewable sources (the Renewable Energy Directive) which sets out the mandatory national targets for individual Member States to meet by 2020. As part of this, the UK is subject to a mandatory national target of deriving 15% of gross final energy consumption from renewable sources by 2020.

5.1.2 National Policy Statement

The Overarching National Policy Statement for Energy (NPS EN-1) sets out the Government's policy for the delivery of major energy infrastructure. It states that 'Large scale deployment of renewables will help the UK to tackle climate change' and that 'offshore wind is expected to provide the largest single contribution towards the 2020 renewable energy generation targets' (DECC 2011b). NPS EN-1 also states that given the level and urgency of need for large scale infrastructure (including renewables), the Infrastructure Planning Commission (IPC) should start with a presumption in favour of granting consent to applications for energy NSIPs.

The National Policy Statement for Renewable Energy Infrastructure (NPS EN-3) states that the Government has assessed the environmental implications and spatial interactions of 25 GW of new offshore wind capacity, in addition to the existing plans for 8 GW of offshore wind and concluded that there are no overriding environmental considerations to prevent the achievement of the plan/programme for offshore wind, if mitigation measures are implemented to prevent, reduce and offset significant adverse effects (DECC 2011a). In line with Recommendation 6 of the Post Consultation Report, there is also potential for capacity extensions to existing wind farm leases within UK waters. NPS EN-3 also calls for flexibility in the application process for offshore wind NSIPs, to allow for situations where full details of the project specification may be unknown at the time of submission.

5.1.3 Marine Policy Statement

The UK Marine Policy Statement (HM Government 2011) states that decision makers should take into account the following when examining and determining applications for energy infrastructure:

- The national level of need for energy infrastructure as set out in the Overarching National Policy Statement for Energy (EN-1);
- The positive wider environmental, societal and economic benefits of low carbon electricity generation and carbon capture and storage as key technologies for reducing carbon dioxide emissions; and
- The potential impact of inward investment in offshore wind, wave, tidal stream and tidal range energy related manufacturing and deployment activity; as well as the impact of associated employment opportunities on the regeneration of local and national economies. All of these activities support the objective of developing the UK's low carbon manufacturing capability.

5.2 Test 2: No satisfactory alternative

In order to minimise the impacts on EPS, alternative solutions should be considered in order to prevent impairment to the Natura 2000 network, whilst still fulfilling the public need for the project. NPS EN-3 allows for flexibility in the application process for offshore wind NSIPs, to enable situations where full details of the project description may be unknown at the time of submission. The exact design parameters for Thanet Extension are undecided and therefore different design scenarios have been presented. This section outlines the site selection process and the consideration of alternative WTG designs and foundation types considered in the application.

5.2.1 Site selection

The specific constraints on site selection have been presented in Volume 1, Chapter 4 Site Selection and Alternatives (Document Ref: 6.1.4). In summary, a number of fundamental principles have been inherently applied to the decision-making process, and these comprise:

- Shortest route preference for cable routing to minimise cost, construction timescales, and transmission losses;
- Avoidance of key sensitive features where possible and where not, seek to mitigate impacts;
- 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 (i.e. ruling out overhead lines).

In order for the UK to meet its renewable energy targets by increasing offshore wind development, sites around the UK were identified as having potential for offshore wind development. Given the existing presence of the Thanet Offshore Wind Farm and its operational output, the area within which Thanet Extension is located was identified as a good site for wind resource.

In 2009 there was a bidding process for extensions to Round 1 and Round 2 wind farm sites that were either consented or had submitted consent applications for determination (Round 2.5). Thanet Extension was not brought forward at the time, however The Crown Estate requirements for Round 2.5 Projects have been considered in the development of Thanet Extension. These requirements included:

- To be of an appropriate scale to the original site,
- Take into consideration environmental parameters and other constraints,
- Share a substantial part of one or more boundaries with the original site,
- Demonstrate synergies with the original site e.g. of construction, operation, improvement of economics and/ or grid connectivity, and
- Not be within 5 km of another wind farm site, except with the express agreement of the tenant of that site and not adversely affect delivery or operation of the original site or any neighbouring site.

The location of the Thanet Extension wind turbine generators (WTGs) were identified following consideration of the environmental parameters and an analysis of engineering, environmental, economic and consenting risks and subject to further feasibility analysis for key areas of concern.

5.2.2 Number of turbines

At the time of submission of the ES, the project design for Thanet Extension has yet to be finalised and flexibility in the type of turbine and number of turbines has been retained in order to ensure that any changes in the available technology and project economics can be accommodated within the consented project design. The impact assessment for Thanet Extension was therefore conducted against the maximum worst-case scenario in terms of turbine design and number of turbines. The WTG sizes under consideration within the Thanet Extension impact assessment are 8, 10 and 12 MW

WTGs. The number of turbines installed will depend on the turbine type installed in order to meet the maximum project capacity of 340 MW.

5.2.3 Foundation type

As with the turbine type and number of turbines, the foundation type that will be used to install the WTGs has yet to be finalised, and the project design for Thanet Extension retains flexibility in foundation type. The final foundation type that will be installed will depend on WTG type, physical and environmental constraints, project economics and supply chain strategy. There are a number of foundation types under consideration and the final types will not be confirmed until post-consent. Therefore, the Thanet Extension impact assessment considered a range of foundation types, including:

- Piled monopile foundations,
- Piled quadropod or tripod jacket foundations, and
- Suction caisson quadropod or tripod jacket foundations.

5.2.4 Embedded Mitigation

Mitigation measures that were identified and adopted as part of the evolution of the project design (embedded into the project design) and that are relevant to marine mammals are listed in (Table 2).

If, given economic, physical and environmental constraints, it is determined that there are no satisfactory alternative to the percussive piling of monopile and jacket foundations, the project has developed a piling Marine Mammal Mitigation Plan (MMMP) (Document Ref: 8.11) that has been submitted to the MMO and Natural England which includes details of the soft-start and ramp-up procedures, marine mammal monitoring zones, and the use of acoustic deterrents that will be employed in order to reduce the risk of injury to negligible.

Table 2 Embedded mitigation relating to marine mammals.

Parameter	Mitigation measures embedded into the project design
General	
Vessels	A vessel management plan (VMP) including vessel operator codes of conduct will be developed as part of the Project Environmental Management and Monitoring Plan (PEMMP) including advice to operators to not deliberately approach marine mammals, to travel on predictable routes as far as is possible and to avoid abrupt changes in course or speed should marine mammals approach the vessel to bow-ride.
Construction	
Pile-driving	An MMMP for pile driving activities has been drafted for Thanet Extension, with the aim to prevent instantaneous auditory injury to any marine mammal species in close proximity of the pile driving for the foundation structures (Document Ref: 8.11). The MMMP follows the guidance provided by JNCC (2010) and recent SNCB recommendations with regards to ADD use. This outlines the use of a Lofitech AS seal scarer ADD to deter marine mammals out of the PTS impact zone during a pre-soft-start activation period, in conjunction with MMO pre-piling visual observations. A piling soft-start will be implemented where 10% hammer energy will be used for the first 20 minutes followed by a 40 minute ramp-up between 10 and 100% hammer energy.

Parameter	Mitigation measures embedded into the project design
Pollution prevention	A Project Environmental Management and Monitoring Plan (PEMMP) will be produced and followed to cover the construction and O&M phases. This will also incorporate plans to cover accidental spills, potential contaminant release and include key emergency contact details (e.g. MMO, Maritime and Coastguard Agency and the project site co-ordinator). A decommissioning programme will be developed to cover the decommissioning phase. The purpose of the measures to be implemented ensure that potential for contaminant release is strictly controlled and therefore provides protection to marine life across all phases of the life of the project.
Operation	
EMF	Cable burial to a minimum target depth of one meter (where possible and subject to risk assessment) will increase the distance between cables and benthic receptors, thereby reducing the strength of the received EMF.
Decommissioning	
Embedded mitigation measures implemented in the Decommissioning Phase are likely to be similar to those implemented during the Construction Phase.	

5.3 Test 3: Favourable conservation status

The UK harbour porpoise has been assessed as having a Favourable conservation status (JNCC 2013). The following section outlines the impacts of pile driving as a result of Thanet Extension as well as the potential cumulative impacts as a result of construction at other windfarms; and provides an assessment of whether or not these predicted impacts are likely to cause a change in the Favourable conservation status of the harbour porpoise population.

5.3.1 Pile driving

5.3.1.1 PTS

The maximum PTS impact range for porpoise is 960 m for the installation of monopiles at Location East (Table 3). Therefore, with the adoption of an agreed MMMP which includes an appropriate mitigation zone prior to the onset of piling, and the implementation of a soft start, the risk of instantaneous PTS to any harbour porpoise is extremely low. The magnitude of the impact is therefore assessed as **Negligible** in the marine mammal impact assessment (Volume 2, Chapter 7: Marine Mammals, Document Ref: 6.2.7).

Table 3 Estimated impact areas and ranges for harbour porpoise PTS at full hammer energy.

	East				South west			
	Monopile (5,000 kJ)		Pin Pile (2,700 kJ)		Monopile (5,000 kJ)		Pin Pile (2,700 kJ)	
NOAA (NMFS, 2016)	**Area (km^2)**	**Range (km)**	**Area (km^2)**	**Range (km)**	**Area (km^2)**	**Range (km)**	**Area (km^2)**	**Range (km)**
unweighted SPL_{peak} 202 dB re 1µPa	1.37	0.66	0.63	0.45	0.993	0.56	0.474	0.39
weighted SEL_{cum} 155 dB re 1 μPa^2s	0.010	0.060	3.000	**0.960**	0.004	0.040	0.338	0.330

5.3.1.2 Disturbance (fixed threshold)

Based on a fixed threshold of an SEL of 145 (Lucke *et al*. 2009), the estimated maximum impact range for 'possible avoidance' is 28.4 km (Table 4). This equates to a maximum of 1,621 porpoise (0.47% MU) using the SCANS III density or 1,631 porpoise (0.47% MU) using the APEM density potentially experiencing noise levels high enough to elicit a behavioural response (Table 5).

Table 4 Estimated impact ranges for 'possible avoidance' for harbour porpoises based on a threshold of 145 dB (re 1 μPa^2s) from Lucke et al. (2009).

	East				South West			
	Monopile (5,000 kJ)		Pin Pile (2,700 kJ)		Monopile (5,000 kJ)		Pin Pile (2,700 kJ)	
	Area (km^2)	**Range (km)**	**Area (km^2)**	**Range (km)**	**Area (km^2)**	**Range (km)**	**Area (km^2)**	**Range (km)**
Lucke *et al.* (2009)	**mean**				**mean**			
unweighted SEL_{ss} 145 dB re 1 μPa^2s	2,670	**28.4**	2,100	24.3	1,261	19.2	947	16.8

Table 5 Number of harbour porpoises within the impact area of the behavioural fixed threshold based on Lucke et al. (2009).

	East		South West	
	Monopile (5,000 kJ)	**Pin Pile (2,700 kJ)**	**Monopile (5,000 kJ)**	**Pin Pile (2,700 kJ)**
SCANS III				
Number of animals	**1,621** (589 – 3,036)	**1,275** (464 – 2,388)	**766** (278 – 1,434)	**575** (209 – 1,076)
% of reference population	**0.47%** (0.2 - 0.9)	**0.37%** (0.1 - 0.7)	**0.22%** (0.08 - 0.4)	**0.17%** (0.06 - 0.3)
APEM surveys				
Number of animals	**1,631** (0 – 10,975)	**1,283** (0 – 8,633)	**770** (0 – 5,184)	**578** (0 – 3,890)
% of reference population	**0.47%** (0 – 3.18)	**0.37%** (0 – 2.50)	**0.22%** (0 – 1.50)	**0.17** (0 – 1.13)

The SCANS III numbers are based on the mean density estimate (+/- 95% confidence interval) and are also given as the percentage of the reference population. The APEM numbers are based on the mean density estimate across all surveyed months and are also given as the percentage of the reference population.

5.3.1.3 Disturbance (dose-response)

Using the dose-response curve approach in combination with the APEM density estimates, the maximum number of porpoise predicted to experience disturbance is 1,888 porpoise which equates to 0.55% of the MU (Table 6).

Given these low percentages of the population predicted to be affected across both methods, the fact that the piling will be intermittent over a period of approximately four months, lasting a maximum total amount of active piling of up to 170 hours for monopiles and 230 hours for pin piles, with breaks in between pile installations, the effects are considered to be temporary and reversible, affecting only a small proportion of the relevant MU, and the magnitude of the impact is assessed as **Low** in the marine mammal impact assessment (Volume 2, Chapter 7: Marine Mammals, Document Ref: 6.2.7).

Table 6 Number of harbour porpoises within the impact area of the behavioural dose response method based on Thompson et al. (2013).

	East		South West	
	Monopile (5,000 kJ)	**Pin Pile (2,700 kJ)**	**Monopile (5,000 kJ)**	**Pin Pile (2,700 kJ)**
SCANS III				
Number of animals	**1,880** (265 – 2,558)	**1,546** (188 – 2,157)	**989** (122 – 1,404)	**788** (87 – 1,146)
% of reference population	**0.54%** (0.07 - 0.73)	**0.45%** (0.05 - 0.61)	**0.29%** (0.03 - 0.40)	**0.23%** (0.02 - 0.32)
APEM surveys				
Number of animals	**1,888** (265 – 2,577)	**1,551** (188 – 2,168)	**989** (122 – 1,405)	**788** (87 – 1,146)
% of reference population	**0.55%** (0.08 – 0.75)	**0.45%** (0.05 – 0.63)	**0.29%** (0.04 – 0.41)	**0.23%** (0.03 – 0.33)

The SCANS III numbers are based on the mean density estimate (+/- 95% confidence interval) and are also given as the percentage of the reference population. The APEM numbers are based on the mean density estimate across all surveyed months (lower and upper bound of the dose response curve) and are also given as the percentage of the reference population.

5.3.1.4 Conclusion

The risk of PTS to any individual as a result of piling at Thanet Extension is negligible, therefore there is no risk of any effects on the North Sea harbour porpoise population.

The magnitude of disturbance impact as a result of piling at Thanet Extension is low, which means that the survival and reproductive rates are unlikely to be impacted and therefore the population trajectory is unlikely to be altered.

The piling at Thanet Extension is therefore not predicted to effect the population dynamics of the harbour porpoise MU nor will it affect the ability of the population to maintain itself on a long-term basis as a viable element of its natural habitats. Therefore, the piling at Thanet Extension is not predicted to result in a change in the favourable conservation status of the North Sea harbour porpoise population.

5.3.2 Cumulative Impacts

Cumulative effects refer to effects upon receptors arising from Thanet Extension when considered alongside other proposed developments and activities and any other reasonably foreseeable project(s) proposals. For those projects where piling may overlap with the piling phases at Thanet

Extension, modelled behavioural impact ranges (likely avoidance and possible disturbance), as presented in published ESs, are presented in Table 7. These are divided into:

- Tier 1 projects: projects/ plans already constructed or currently under construction and/ or those consented but not yet implemented, where data confidence in the project design envelope and timeline for construction is high. This means that these projects have a Contract for Difference (CfD) in place and/or have commenced with the formal submission of discharge plans to the regulators, and therefore there can be confidence as to final scheme design and timing.
- Tier 2 projects: projects/ plans which are consented but not yet implemented, and where data confidence in the project design envelope and timeline for construction is medium. For example, the consented envelope may not be what is constructed, or timelines might have changed since the ES was submitted. The project may not yet proceed as a result of financial or other considerations. This Tier includes consented UK projects which have not yet been awarded a CfD.

While the number of animals predicted to experience disturbance effects for each Tier 1 and Teir 2 project is included in Table 7 for information, only Tier 1 is included in the cumulative assessment here since these are the only projects for which data confidence in the project design envelope and timeline for construction is high.

All UK Tier 1 projects' impact assessments for subsea noise from pile-driving have presented smaller hammer energies therefore the potential ranges for PTS from CEA projects are likely to be smaller than for Thanet Extension. In addition, these projects have all have committed to the implementation of mitigation measures, to reduce the likelihood of PTS to negligible. As potential impact ranges are small and any risk expected to be reduced to negligible by the adoption of project specific mitigation procedures (including visual and passive acoustic monitoring to ensure the impact zone is free of marine mammals before piling begins, use of acoustic deterrents to move marine mammals out of predicted impact zones and the adoption of piling soft starts), the residual magnitude of impact is predicted to be **Negligible** across all projects. Therefore, PTS in not considered in the cumulative assessment.

For indicative purposes if the Tier 1 numbers presented in Table 7 are summed, and include the Thanet Extension prediction, this provides a total for harbour porpoise displacement of 12,000 across Tier 1, which is equivalent to 3.47% of the MU population. Booth *et al*. (2017) reported that the cumulative

effects on the North Sea harbour porpoise population as a result of offshore wind farm construction in eastern English waters (with an effect magnitude of 15%) would not present a significant risk of a long-term effect on the North Sea harbour porpoise population. More recent population modelling using the DEPONS model has demonstrated that the North Sea harbour porpoise population was not affected by the construction of 65 offshore wind farms within the North Sea (assuming porpoise responded in the same way as recorded during construction at the Gemini wind farm) (Nabe-Nielsen et al. 2018). The modelling results demonstrated that, at the North Sea scale, the population dynamics of the impacted population (when responding out to 8.9 km from construction sites) was indistinguishable from the baseline scenario. It is therefore considered that a total of 3.47% effect magnitude would similarly not pose a risk to the long-term health of the North Sea harbour porpoise population.

Even though the effects are likely to be temporary and any short-term changes in the ability of individual porpoises to reproduce over the period experiencing disturbance, are likely to be reversible, an effect on 3.47% of the population has been assessed as **Low** magnitude. It is important to note that when taking into account overlap with all other potential offshore wind farm projects within the MU, the relative contribution of Thanet Extension is very low. In quantitative terms, predicted displacement from Thanet Extension constitutes only 13.6% of the total predicted disturbance.

Table 7 Modelled behavioural impact ranges and number of animals predicted to be disturbed for harbour porpoise due to piling at Tier 1 and Tier 2 projects with piling predicted in the years adjacent to piling at Thanet Extension.

Tier	Project	Impact range	Number of animals predicted to be affected		Predicted impact of significance
			Single	Concurrent	
1	**Triton Knoll**	16.6 km (90 dBht)	357 (90 dBht)	Not predicted to be significantly higher than for individual piling events.	Minor
	Moray East	22 km (75 dBht)	2993	3442	Major significance over medium term for individuals during construction phase with minor significance long-term effects on the population.
	Hornsea Project Two	62 km (145 SEL, dose response)	3809	6570	Moderate (short to medium term) No significant effect in the long-term
	Borssele	No ranges or numbers predicted – mitigation expected to avoid significant effects: Limiting sound production during pile-driving to a maximum value to be determined between 160 and 172 dB re µPa^{2}s at 750 metres			
2	**Dogger Bank Creyke A**	19.5-26 km (SEL 145)	1288 (SEL 145)	3119 (SEL 145)	Negligible (single) Minor adverse (concurrent)
	Dogger Bank Creyke B	24-43 km (SEL 145)	2276 (SEL 145)	4394 (SEL 145)	Negligible (single) Minor adverse (concurrent)
	Dogger Bank Teeside A	22-33.5 km (SEL 145)	1920 (SEL 145)	4302 (SEL 145)	Negligible (single) Minor adverse (concurrent)
	Sofia	22-33.5 km (SEL 145)	2035 (SEL 145)	3931 (SEL 145)	Negligible (single) Minor adverse (concurrent)
	East Anglia Three	26 km	2869 (EDR)	2869 (EDR)	Spatial worst-case Minor Temporal worst-case Negligible

Booth *et al*. (2017) recently carried out an iPCoD assessment of the cumulative effects on the North Sea harbour porpoise population as a result of a number of scenarios of OWF construction in eastern English waters. This assessment included many of the projects included in the cumulative assessment presented here (Dogger Bank Teesside A&B, Dogger Bank Crekye Beck A&B, Triton Knoll, Hornsea Two and East Anglia Three). While the iPCoD model is subject to many assumptions and uncertainties relating to the link between impacts and vital rates, the model presents the best available scientific expert opinion at this time. Further information on the assumptions and limitations of this approach can be found in Booth *et al*. (2017), Harwood et al. (2014) and King et al. (2015).

Booth *et al*. (2017) calculated the "additional risk of a population decline" imposed by various construction scenarios. Worst-case assessed included scenarios with up to 34,000 animals being predicted to experience disturbance from piling noise across a range of OWF projects. This was equivalent to 15% of the total MU population size estimate at the time of assessment. Based on absolute worst-case assumptions across all input parameters (animal densities, responses, piling scenarios, days of residual disturbance, and the proportion of population vulnerable to impacts) the maximum predicted impact was only a six percent increase in the probability of a one percent or greater population decline. This analysis suggests that a cumulative impact of this magnitude would not have a long-term effect on the North Sea harbour porpoise population.

While iPCoD modelling has not been conducted for the cumulative assessment for Thanet Extension, the total number of animals predicted to experience disturbance across these Tier 1 projects (Table 7) is equivalent to only 3.47% of the MU, which is considerably less than the 15% of the MU predicted to experience disturbance in the worst-case scenario assessed in Booth *et al*. (2017). Since the disturbance of 15% of the MU resulted in a very low risk of a 1% population decline after 6 or 12 years, the disturbance to only 3.47% of the MU (as assessed here) is also unlikely to result in a 1% population decline and therefore it can be concluded that the cumulative disturbance resulting from the construction on the offshore windfarms presented in Tier 1 in Table 7, in conjunction with Thanet Extension, will not result in a change in the favourable conservation status of the North Sea harbour porpoise population.

6 Conclusions

In conclusion, this draft EPS License Assessment for Thanet Extension has provided the necessary information required to complete the three EPS tests to demonstrate 1) how the IROPI criteria are met, 2) how alternative design parameters have been considered and 3) how the project will not alter the favourable conservation status of the harbour porpoise population.

It should be highlighted that should an EPS license be required, this draft EPS License Assessment will require updating with the finalised project design and construction methods.

7 Glossary of Terms, Acronyms and Abbreviations

Term	Description
MU	Management unit
MMO	Marine mammal Observer
ADD	Acoustic deterrent device
EMF	Electromagnetic Field
MMMP	Marine Mammal Mitigation Protocol
EPS	European Protected Species
SAC	Special Area of Conservation
JNCC	Joint Nature Conservation Committee
FCS	Favourable Conservation Status
IAMMWG	Inter-Agency Marine Mammal Working Group
NOAA	US National Oceanographic and Atmospheric Administration
IROPI	Imperative Reasons of Overriding Public Interest
IPC	Infrastructure Planning Commission
NSIP	Nationally Significant Infrastructure Project
PTS	Permanent Threshold Shift
iPCoD	Interim Population Consequences of Disturbance framework
VMP	Vessel Management Plan
PEMMP	Project Environmental Management and Monitoring Plan
NPS EN-1	Overarching National Policy Statement for Energy
EN-3	National Policy Statement for Renewable Energy Infrastructure

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