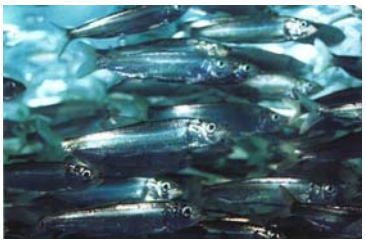
Appendix K

ERM Noise Assessment





ERM

TEDA MAREA Noise and Vibration Technical Report

Thames Estuary Dredging Association (TEDA)

Final Report

15 October 2010

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Thames Estuary Dredging Association

TEDA MAREA Noise and Vibration Technical Report:

Final Report

October 2010

For and on behalf of
Environmental Resources Management

Approved by: Kevin Murphy

Signed: 

Position: Partner

Date: 15th October 2010

CONTENTS

1 TEDA NOISE AND VIBRATION TECHNICAL REPORT

1.1 INTRODUCTION

Noise and vibration from marine activities have the potential to adversely impact marine mammals and fish. They have been shown to produce behavioural responses and at high levels, cause temporary and permanent deafness (1).

Eight licensed dredging areas currently exist within the TEDA study area, with a further three areas either under tender or prospecting. This study assesses the potential effects of noise from dredging activities in the TEDA study area on key species of marine mammals and fish. Vibration that may be produced as a result of dredging is not considered to be at a level which will significantly impact the species for which vibration sensitivity information is available. This is discussed further in *Section 1.6*.

This study has been informed by interpreting the findings from the Assessment of Underwater Noise from Dredging Operations on the Hastings Shingle Bank (2).

1.2 SOURCES OF INFORMATION

The main sources of data used for this assessment include;

- Anatec UK Ltd. 2009. Navigation Impacts Review: Outer Thames Estuary Dredging Area (Technical Note).
- Parvin, S. Nedwell, J. Kynoch, J. Lovell, J. Brooker, A. 2008. Assessment of Underwater Noise from Dredging Operations on the Hastings Shingle Bank. Subacoustech Report Number 758R0137.
- Parvin, S. Nedwell, J. Workman, R. 2006. Underwater Noise Impact Modelling in Support of the London Array, Greater Gabbard and Thanet Offshore Windfarm Developments. Subacoustech Report Number 710R0517.
- Thomsen, F. Ludemann, K. Kafemann, R. Piper, W. 2006. Effects of Offshore Wind Farm Noise on Marine Mammals, Fish and Biota. On behalf of COWRIE Ltd; Hamburg, Germany.

(1) Turnpenny, A. W. H., Thatcher, K. P., and Nedwell, J. R. (1994). The effects on fish and other marine animals of high-level underwater sound. Report FRR 127/94, Fawley Aquatic Research Laboratories, Ltd., Southampton, UK.
(2) Parvin, S. Nedwell, J., Kynoch, J., Lovell, J., and Brooker, A. 2008. Assessment of Underwater Noise from Dredging Operations on the Hastings Shingle Bank. Subacoustech Report Number 758R0137.

- Vella, G. Rushforth, I. Mason, E. Hough, A. England, R. Styles, P. Holt, T. Thorne, P. 2001. Assessment of the Effects of Noise and Vibration From Offshore Wind Farms on Marine Wildlife. ETSU W/13/00566/REP. DTI/Pub URN 01/1341.

- Nedwell, J. Parvin, S. Edwards, B. Workman, R. Brooker, A. Kynoch, J. 2007. Measurement and Interpretation of Underwater Noise During Construction and Operation of Offshore Wind Farms in UK Waters. Subacoustech Report No. 544R0738 to COWRIE Ltd.

1.3 BASELINE

1.3.1 Introduction

This section presents a qualitative description of the baseline (ambient) noise environment and an account of the marine species present in the outer Thames Estuary MAREA study area. The subsequent impact assessment focuses on the behavioural responses of species, which may arise from noise due to dredging activities, and does not look at the change in the baseline noise level except to note that where baseline levels are comparatively high, they may mask the noise from dredging.

Ambient sea noise comprises a variety of individual sources, some of which are natural and some man-made. The study area is heavily used by cargo and fishing vessels. Additionally, there is currently one offshore wind farm in operation and several further wind farms under construction. Noise from these activities will combine with naturally occurring noise from sources such as waves breaking, wind, rain and animal calls to define the baseline environment.

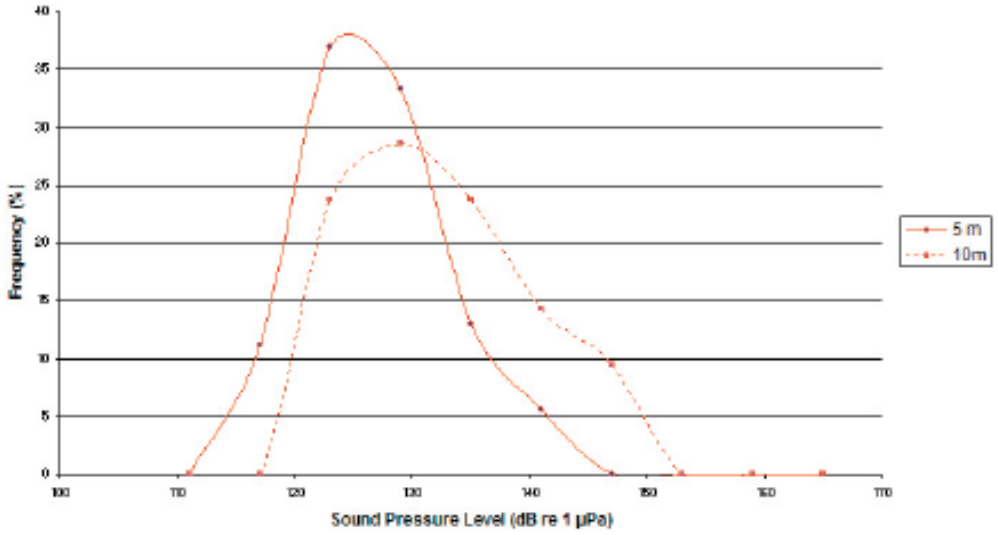
In general the levels of baseline noise that have been recorded at operational and construction stage offshore wind farm sites around the UK coasts tend to suggest that noise levels in coastal areas are relatively high (1). Typical baseline noise levels of 130-140 dB re 1 Pa have been recorded. Measurements suggest that at frequencies of approximately 2kHz to 100kHz there is little variability in the level of noise, and it is thought that this band corresponds to wind and wave-generated noise. However at frequencies below 1kHz there is significant variability in levels, which is thought to be due to shipping movements. Sound pressure levels vary more during the daytime due to the higher number of local ship movements. It was also found that noise levels are higher at low wind speeds, contrary to the normal assumption that they will rise with increasing wind speed. However it is not possible to unequivocally determine the reason for this (1).

(1) Nedwell, J. R., Langworthy, J. and Howell, D. 2003. Assessment of sub-sea acoustic noise and vibration from offshore wind turbines and its impact on marine wildlife; initial measurements of underwater noise during construction of offshore windfarms, and comparison with background noise. Subacoustech Report No 544RO423. Published by COWRIE.

No baseline underwater noise measurements were recorded within the study area as part of this MAREA. However, a set of 115 baseline noise recordings were made around the Greater Gabbard wind farm sites (Inner Gabbard and the Galloper), which are situated within the northeast and eastern parts of the study area (see *Section 6.3* of the MAREA).

Noise levels were found to be typical of coastal noise, with a high level at low frequencies (perhaps from distant shipping) and a rapid decrease in level with frequency [(1)]. *Figure 1.1* indicates the frequency distribution of the noise Sound Pressure Level across the baseline noise measurements. In general the baseline noise levels range from 110 to approximately 150 dB re 1 µ Pa. The levels are centred around a mean of roughly 125 dB re 1 µ Pa at a depth of 5 metres, and a slightly higher mean of 130 dB re 1 µ Pa at a depth of 10 metres. It should be noted that these data are a 'snapshot' taken on one day and therefore levels may fluctuate with varying conditions.

Figure 1.1 ***The Distribution of Background Noise Measurements from the Greater Gabbard Site***



Source: Greater Gabbard Environmental Statement

Baseline noise levels elsewhere in the TEDA study area are likely to vary depending on the proximity to shipping channels and other major noise sources. In particularly noisy areas, baseline noise levels may mask those produced by dredging activities.

(1) Nedwell, J. R., Workman, R. and Parvin, S. J. 2005. The assessment of likely levles of piling noise at Greater Gabbard and its comparison with background noise, including piling noise measurements made at Kentish Flats. Subacoustech Report No. 633R0115

1.3.2 Anthropogenic Noise Sources

Overview

A variety of anthropogenic activities take place within the TEDA MAREA study area. These activities will create underwater noise and will combine to form the baseline noise environment in combination with natural underwater noise sources.

General Shipping

The study area is heavily shipped by commercial vessels (1). Anatec UK Ltd carried out a survey of automatic identification system (AIS) equipped vessels (which covers the vast majority of commercial shipping). The study showed that a large number of vessels traverse the study area heading to / from Thames Port and Harwich Haven. An average of 145 ships per day during the 40 day survey period was recorded. The majority of these movements was cargo vessels (63% or 91 movements per day) and tankers (14% or 20 movements per day). The number of deeper draughted and longer container ships passing through the study area is expected to increase with the construction of the London Gateway deepwater port within the river Thames (first berth intended to be fully operational by 2011) and the Felixstowe port enhancement (completion expected 2014).

Fishing Vessels

The southern North Sea and Outer Thames Estuary have been important areas for populations of a number of commercial fish species for centuries, and a wide variety of fisheries have developed to exploit them.

According to VMS (Vessel Monitoring System) and overflight data, 220 beam trawlers were observed in the study area in 2007. Another 120 vessels operating in the area were made up of other trawl gears, gill nets, potters/whelkers and suction dredgers.

Recreational and Military Vessels

It has been highlighted during consultation with the Cruising Association / Royal Yachting Association that the study area is heavily used by recreational craft, mostly using the deep water channels (1). Additionally, the study area encompasses a number of military and navy submarine exercise and practice areas.

Wind Farm Construction

One 'round one' wind farm has been constructed and another is currently under construction within the TEDA study area. Two 'round two' wind farms are also being constructed and a further two are consented for development.

(1) Navigational Impacts Review. Outer Thames Estuary Dredging Area (Technical Note). Anatec UK Ltd, 2009.

During wind farm construction, there is likely to be an increased volume of traffic. Noise from the use of pile driving equipment has the potential to produce high levels of underwater noise, dominating the baseline noise environment over a wide area. It has been estimated that such noise may produce a strong behavioural avoidance response in the harbour porpoise from 4 km in shallow waters up to 13 km in deeper waters around the TEDA study area [(1)] . By comparison, it has been estimated that noise from dredging activities may produce a similar response in relatively shallow water at up to 500 m [(2)] (see Section *1.4.2*).

1.3.3 Marine Species within the Study Area

Underwater sound has the potential to impact upon the receptors in the marine environment. All marine mammals and some fish species are the main marine receptors that sound emissions might affect, based on the underwater hearing sensitivity of these receptors in the frequency range of most anthropogenic underwater noise.

A desktop assessment of the key marine mammal populations within the study area has been carried out as part of the marine mammal baseline section (*Section 5.4* of the MAREA). Populations of the harbour porpoise, common seal and grey seal have been recorded in the study area. These are considered to be the most common marine mammal species in the Thames estuary and as a result are more likely to be present and therefore experience impacts from dredging operations.

Similarly, a desktop assessment of the key fish species within the study area has been carried out (*Section 5.3* of the MAREA).

The following species represent the most important species in the area from a commercial and/or ecological perspective and will therefore be considered in this assessment of potential noise impacts:

- cod;
- bass;
- plaice;
- sole;
- herring;
- sprat;
- mackerel;
- lesser-spotted dogfish; and
- thornback ray.

Several protected species are thought to be resident within the study area or temporarily present during their seasonal migrations from rivers and estuaries

(1) Underwater Noise impact Modelling in Support of the London Array, Greater Gabbard and Thanet Offshore Wind Farm Developments. Subacoustech Report Number 710R0517. Parvin, Nedwell, Workman. 2006.
(2) Parvin, S., Nedwell, J., Kynoch, J., Lovell, J. and Brooker, A. 2008. Assessment of Underwater Noise from Dredging Operations on the Hastings Shingle Bank. Subacoustech Report Number 758R0137, 2008.

to the open sea. However none of these are populations of national importance and they do not form part of a SAC or other protected area. They will be included in this assessment for completeness however. These species include:

- sea lamprey;
- seahorses; and
- sand goby.

1.4 IMPACT ASSESSMENT METHODOLOGY

1.4.1 Introduction

In order to fulfil the requirements of the TEDA MAREA, an assessment of the effects of underwater noise due to dredging within the study area has been carried out with the aim of providing '*a context for site-specific EIAs within the relevant REA area and to identify site-specific issues that individual EIAs may need to focus on more specifically*' (1).

The modelling of underwater noise propagation is a complex procedure involving many interacting factors that can have a significant effect on the resulting predictions. Such factors include water depth, temperature, salinity and the interaction of the waterborne sound field with the underlying sea bed substrate. Additionally, acoustic signals travelling in shallow water, when compared to deeper water, are severely degraded and attenuated due to the multiple interactions of the waterborne sound with the sea bottom and sea surface. As a result, detailed data would be required to undertake a full, quantitative assessment, and these are not currently available for the MAREA survey area. This assessment has therefore been based on measurements of underwater noise from dredging in a similar area along the Sussex coast.

Little information is currently available on the sensitivity to vibration of the species under consideration. An assessment has been made based upon studies carried out on the fiddler crab (2).

1.4.2 Noise Assessment Methodology

An assessment of the effects of dredging noise on fish and marine mammals along the southeast coast of England, (the Sussex coast) was carried out by Subacoustech in 2008 (3) (hereafter referred to as the Hastings report). The study area in the Hastings report represents a similar environment to that in the outer Thames Estuary MAREA area. As such, the zones of behavioural

(1) Cefas, JNCC, Natural England, English Heritage. 2008. Regional Environmental Assessment: A Framework for the Marine Minerals Sector. (RAG Guidance).
(2) Aicher, B. Markl, H. Masters M. Kirschenlohr, H. 1983. Vibration transmission through the walking legs of the fiddler crab, Uca pugilator (Brachyura, Ocypodidae) as measured by Laser Doppler Vibrometry. Journal of Comparative Physiology A: Neuroethology, Sensory, Neural, and Behavioral Physiology. 150: 483 – 491
(3) Parvin, S., Nedwell, J., Kynoch, J., Lovell, J. and Brooker, A. 2008. Assessment of Underwater Noise from Dredging Operations on the Hastings Shingle Bank. Subacoustech Report Number 758R0137, 2008.

response for key species presented in the Hastings report form the basis of determining zones of behavioural response from dredging activities associated with the outer Thames Estuary MAREA area.

Effects have been assessed in terms of behavioural responses to underwater noise as a result of dredging activity as it is considered unlikely that auditory injury will occur. A marine animal would have to remain within a few metres of an operational dredger for a number of hours for this to happen. Behavioural observations would indicate that this is highly unlikely (1).

Distances between noise source and receptor, within which a range of behavioural responses are expected (based on observations presented in the Hastings report) are reported in *Table 1.1*.

Table 1.1 Reactions of Marine Species to Noise

	Criteria		
Species	**Strong Behavioural Avoidance Reaction, m**	**Mild Behavioural Avoidance Reaction, m**	**Low Likelihood of Disturbance, m**
Harbour Porpoise	500	2000	5000
Common Seal	70	500	7000
Cod	4	30	1100
Herring	6	60	1900
Dab	<1m	3	130

The behavioural response distances listed in *Table 1.1* and used to inform the assessment are dependent on the following factors:

- the level of ambient noise that already exists in the area;
- the noise source;
- noise attenuation due to propagation through the water; and
- the sensitivity of the marine animals to noise and their behavioural responses.

These factors are discussed in more detail in the following sections.

1.4.3 Existing Ambient Noise Levels

This assessment estimates behavioural responses based on the hearing sensitivity of key species of marine animals to underwater noise. However in order to have an effect on marine animals, the noise from dredging must be above the existing noise levels. Ambient noise levels within the Hastings report study area are likely to be lower than those within the outer Thames Estuary study area due to lower levels of anthropogenic activity, and as such the distances in *Table 1.1* can be considered to be conservative.

1.4.4 *The Noise Source*

Underwater noise measurements taken in October 2007 of the 'City of Westminster' were reported in the Hastings report. This vessel is a trailer suction hopper dredger with a length of 99.9 m, a beam of 17.35 m, a maximum draft of 6.69 m and is powered by two 1950 kW Warsila engines. The vessel can load 5,200 tonnes per cargo working at a loading rate of 2.5 m^3 / second. This usually allows the vessel to complete loading of a full cargo in 2.5 to 3.5 hours.

Measurements were undertaken at ranges of 250 m to 16 km with a hydrophone deployed at water depths of between 7 m and 10 m. By fitting the measured data to a conventional underwater sound propagation model, the data indicate a broadband source sound pressure level of 186 dB re. 1 µPa at 1 m from the dredging vessel. This vessel is considered representative of dredging vessels likely to be used within the outer Thames Estuary MAREA study area. Minor differences in dredger specification are not expected to significantly alter the results of this report.

1.4.5 *Noise Attenuation Due to Propagation through the Water*

The Hastings report included modelling of underwater noise propagation based on a number of measurements of dredging activity in the area at a variety of distances with water depths ranging from less than 10 m to approximately 50 m (lowest astronomical tide).

The charted water depths across the TEDA study area range from 0 m to approximately 70 m (lowest astronomical tide). *Figure 1.1* in Chapter 1 of the MAREA identifies the licence areas located in water depths of either ≤20 m or <50 m. It is considered that both the Hastings and TEDA study areas comprise comparable shallow water environments from an acoustic perspective.

1.4.6 *Marine Animal Hearing Sensitivity and Behavioural Responses*

Effects of dredging noise are assessed in terms of behavioural responses. Various studies have shown that changes in behaviour can occur when fish are exposed to noise (Turnpenny *et al* 1994 (1), Engås and Lokkeborg 2002 (2), Slotte *et al* 2004 (3). Some species display behavioural responses at lower noise levels than others and this depends largely on the sensitivity of a particular species to noise. Estimates of the zones of behavioural response for various marine species have been derived from audiogram data.

(1) Turnpenny, A. W. H., Thatcher, K. P., and Nedwell, J. R. (1994). The effects on fish and other marine animals of high-level underwater sound. Report FRR 127/94, Fawley Aquatic Research Laboratories, Ltd., Southampton, UK.
(2) Engås A, and Lokkeborg S., (2002), Effects of seismic shooting and vessel-generated noise on fish behaviour and catch rates, Bioacoustics 12, 313-315
(3) Slotte, A., Kansen, K., Dalen, J., and Ona, E. (2004). Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. Fish. Res. 67, 143-150

Fish are commonly classified according to their sensitivity to noise as either *hearing specialists* or *hearing generalists* (Fay and Popper 1999 (1)). Hearing specialists have a high sensitivity to underwater sound and vibration as a consequence of their having some means of mechanical coupling between the swim bladder and the inner ear. Hearing generalists may or may not have a swim bladder, but if present it will lack the specialised coupling to the inner ear. The majority of fish are hearing generalists. These species hear primarily through the process of particle motion via the otoliths, and consequently their sensitivity to sound is limited (Fay and Popper 1999 (1)).

Some species of marine animal assessed in the Hastings report are also present in the TEDA study area. Where species in the study area have not been assessed in the Hastings report, results for similar species that were considered have been used to assess likely behavioural responses to dredging noise in the outer Thames Estuary MAREA area. *Table 1.2* lists the marine species that are considered to be important in the MAREA area, and highlights which of the species that were assessed in the Hastings report are the most representative for each, based on what is known (if anything) about their hearing capabilities. In cases where nothing is known about the hearing ability of a species, the hearing specialist herring is used as a representative for conservatism (eg in the case of sea lamprey). Similarly dab is used as a representative of hearing generalists in the absence of species-specific data.

Table 1.2 Reactions of Marine Species to Noise

	Species in Hastings Report				
Important marine species in the study area	**Harbour Porpoise**	**Common Seal**	**Herring**	**Cod**	**Dab**
Harbour porpoise	✓				
Common Seal		✓			
Grey Seal		✓			
Sea lamprey			✓		
Seahorses					✓
Sand goby					✓
Cod				✓	
Bass					✓
Plaice					✓
Sole					✓
Herring			✓		
Sprat			✓		
Mackerel					✓
Lesser-spotted dogfish					✓
Thornback ray					✓

Cetaceans

Harbour Porpoises: Several studies have investigated hearing in harbour porpoises using auditory brainstem-responses (ABR) or behaviourally, using psychometric methods. Harbour porpoises exhibit a very wide hearing range

(1) Fay, R.R. and Popper, A.N. (eds.). Comparative Hearing: Fish and Amphibians. 1999

with relatively poor hearing below 1 kHz, good hearing between 1 and 8 kHz, and are most sensitive from 16 – 140 kHz [1].

Pinnipeds

Common Seals: Underwater audiograms of common seals have been obtained [2]. Their hearing range extends over a very wide frequency range, including the ultrasonic spectrum. The area of best hearing is between 8 and 16 kHz, with acute hearing also at lower frequencies. Common seals are more sensitive to noise than harbour porpoises.

Grey Seal: The common seal is used as the representative species in the absence of any data on behavioural response in the common seal and is expected to have similar characteristics.

Migratory Fish

Sea lamprey: There is evidence of a behavioural response to noise in lampreys [3]. However, a quantitative assessment of their sensitivity to noise is not currently available and such detailed research would be beyond the scope of a Regional Environmental Assessment. In the absence of hearing sensitivity data for this species, the hearing specialist herring has been conservatively adopted.

Protected Species

Seahorses: Seahorses are hearing generalists and consequently have limited hearing ability. Since the dab is also a hearing generalist, it has been used to represent these species.

Sand goby: Gobies have a very small swim bladder and no obvious hearing specialisations; therefore the hearing generalist dab has been used as a representative species.

Demersal Fish

Cod: Atlantic cod have a gas-filled swim bladder. Although there is no direct connection between the swim bladder and ear, the anterior of the swim bladder is in close proximity to the inner ear [4]. Therefore, the species is more sensitive to sound than dab. The Hastings report includes data for cod and these have been used in this assessment.

(1) Kastelein R A, Bunskoek P, Hagedoorn M, Au W W L and Haan D. (2002). Audiogram of the harbor porpoise (*Phocoena phocoena*) measured with narrow-band frequency-modulated signals. J.Acoust.Soc.Am., Vol 112 (1), pp334-344.
(2) Kastak D and Schusterman R J (1998). Low frequency amphibious hearing in pinnipeds: Methods, measurements, noise and ecology. Journal of the Acoustical Society of America, 103(4), 2216-2228
(3) Lenhardt M.L., and Sismour E. (1995))Hearing in the Sea Lamprey (*Petromyzon marinus*) and the long nose gar (*Lepisosteus spatula*).. Available at http://www.aro.org/archives/1995/259.html
(4) Hawkins, A.D. and Johnstone, A.D.F. (1978). The hearing of the Atlantic salmon (*Salmo salar*). J. Fish. Biol. 13, 655-673.

Bass: Sea bass are thought to be hearing generalists[1], therefore the dab has been used to assess likely behavioural responses.

Plaice: Studies indicate that, like other flatfish, the plaice is relatively insensitive to underwater sound. The dab has been used to assess likely behavioural responses to dredging noise.

Sole: The limited underwater noise exposure data that is available for sole comes from research with acoustic fish deterrent systems. These studies indicate that, like other flatfish, the sole is relatively insensitive to underwater sound. The flatfish, dab has been used to assess likely behavioural responses to dredging noise.

Pelagic Fish

Herring: Herring is a member of the order Clupeiforms, all of which are hearing specialists and as such are sensitive to sound. This species is one of the most sensitive species to underwater sound. The Hastings report includes data for this species.

Sprat: A member of the order Clupeiforms, all of which are hearing specialists and as such are sensitive to sound. Therefore the data from the hearing specialist Herring have been used.

Mackerel: Mackerel does not have a swim bladder and is thought to be a hearing generalist; therefore data for the dab have been used to assess likely behavioural responses to dredging noise.

Elasmobranchs

Lesser-spotted dogfish: This is a cartilaginous fish, and is a hearing generalist as it does not possess a swim bladder. As such its hearing ability is likely to be poor. The dab, also a hearing generalist has been used to represent this species.

Thornback ray: This is a cartilaginous fish, and is a hearing generalist as it does not possess a swim bladder. As such its hearing ability is likely to be poor. The dab, also a hearing generalist has been used to represent this species.

1.5 ASSESSMENT OF IMPACTS DUE TO NOISE FROM DREDGING ACTIVITIES

1.5.1 Introduction

The following section describes the predicted behavioural response zones for individual species calculated based on the methodology outlined in *Section*

(1) Lovell, J. M., Findlay, M. M., Harper, G., Moate, R. M. and Pilgrim, D. A. 2005. The polarisation of hair cells from the ear of the European bass (*Dicentrarchus labrax*). Comparative Biochemistry and Physiology, Part A 141: 116-121.

1.4. It goes on to describe the magnitude of the effect, and the sensitivity of the receptors in line with the MAREA assessment methodology in *Chapter 3* of the MAREA.

1.5.2 Zones of Behavioural Response

This report has assessed the effects of underwater noise from dredging on marine animals in terms of zones in which a behavioural response may be observed. Three categories of response have been presented:

- low likelihood of disturbance;
- mild avoidance reaction; and
- strong avoidance reaction.

Noise at or greater than a level which produces a mild avoidance reaction has been considered to be a potentially significant impact, whilst impacts below this level are considered to be insignificant. In order for a mild avoidance reaction to be significant, a significant proportion of the area which is ecologically important to the species (eg haul out sites or spawning, feeding or nursery areas) should be affected.

Individual species may display behavioural responses as they approach dredging areas depending on their hearing sensitivity. Predicted zones of response for species thought to respond at distances greater than 1km from the dredger have been presented in *Figure 1.2* to *Figure 1.7* and are based on the behavioural reaction distances outlined in *Table 1.1*.

- *Figure 1.2* shows the mild behavioural avoidance reaction and low likelihood of disturbance contours for harbour porpoise in relation to the distribution of harbour porpoises in the study area.

- *Figure 1.3* shows the low likelihood of disturbance contour for seals in relation to the potential seal habitat within the study area.

- *Figure 1.4* shows the low likelihood of disturbance contour for cod in relation to the spawning and nursery areas within the study area.

- *Figure 1.5* shows the low likelihood of disturbance contour for herring in relation to the spawning and nursery areas within the study area.

- *Figure 1.6* shows the low likelihood of disturbance contour for sprat in relation to the spawning and nursery areas within the study area.

- *Figure 1.7* shows the low likelihood of disturbance contour for lamprey in relation to the distribution of lamprey within the study area.

The species thought to be subject to a 'low likelihood of disturbance' over a maximum distance of only 130 m from the dredger are not represented in these figures as this zone of response is too small to be shown clearly relative

to the size of the study area. This is the case for species with the lowest hearing sensitivity; ie seahorses, sand goby, bass, plaice, sole, mackerel, lesser-spotted dogfish and thornback ray. The potential sensitivity of each of these species is discussed below:

- **Seahorses** have a coastal distribution and spend the majority of the year at a maximum depth of 12 m, in areas associated with algal growth. They are therefore unlikely to be present within a 130 m radius of the licence areas; the limit at which behavioural responses to dredging noise might occur.

- **Sand gobies** are common all around the UK and the population in the Thames is not thought to be of national significance.

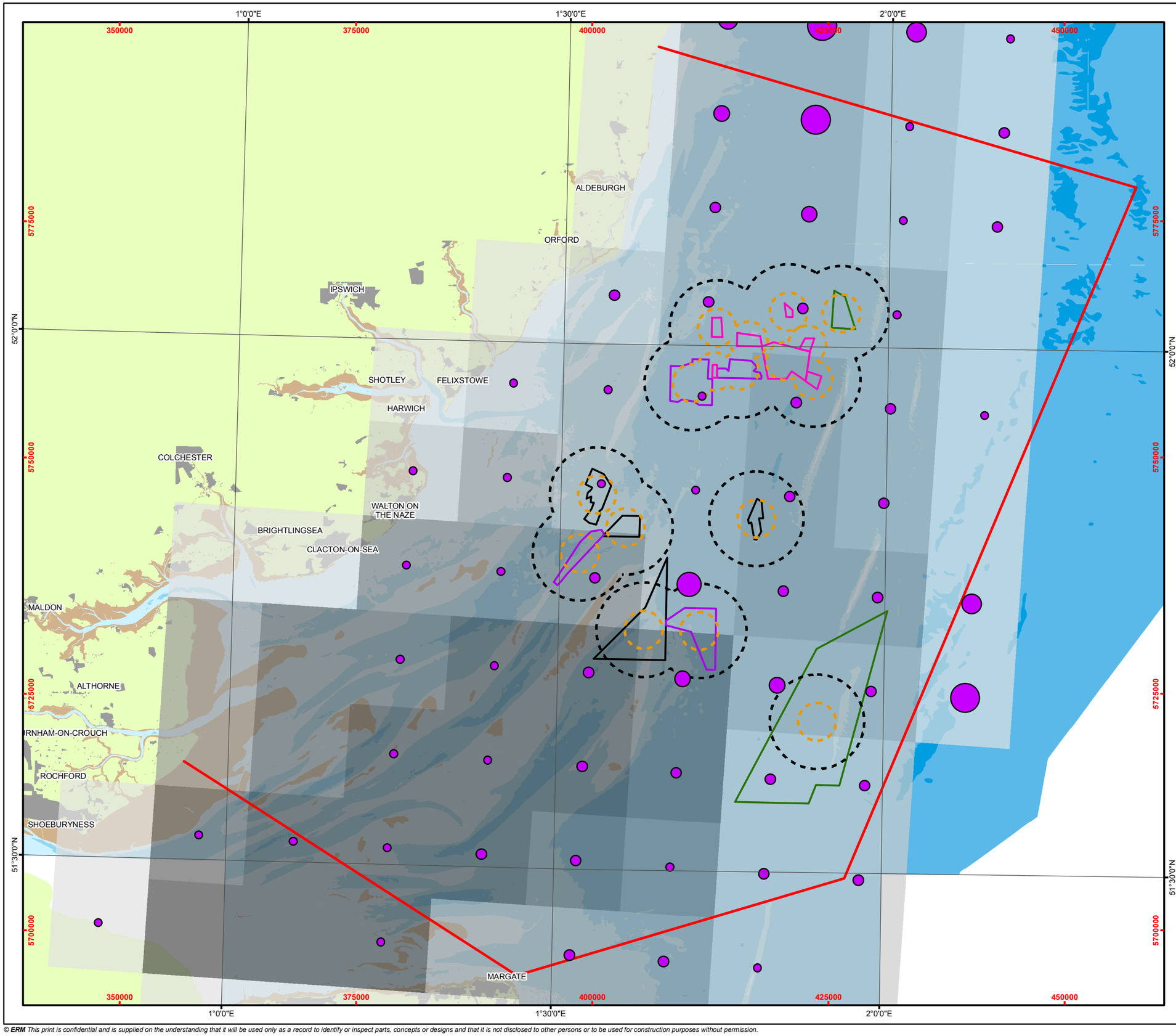
- **Bass** are thought to spawn predominantly in deep water, however fishermen have identified inshore spawning areas associated with the Blackwater estuary within the study area (see *Figure 5*.19 in *Chapter 5* of the MAREA). However these areas do not overlap within 130 m of any dredging areas. The population of bass in the Thames is unlikely to constitute a significant proportion of the national population.

- **Plaice,** and **mackerel** and are widely distributed throughout the study area and the UK as a whole (see *Section 5.3* of the MAREA). In addition their spawning and nursery areas within the southern North Sea are relatively large in size and not particularly concentrated in the study area, therefore any overlap within 130 m of a dredging zone is unlikely to have a significant impact on the national population.

- **Dogfish** also have a wide UK distribution and the study area is not noted as a particularly important spawning or nursery area for this species.

The above species are therefore unlikely to be affected significantly by any noise arising from dredging, and are scoped out of any further assessment.

However, the Thames Estuary is thought to be a particularly important nursery ground for **sole** (*Solea solea*) according to local fishermen and it is also an important stock centre for the **thornback ray** (*Raja clavata*). Consequently, despite their low hearing sensitivity, potential impacts to these species as a result of noise from dredging within the Outer Thames will be considered further in *Section 1.5.5*, together with those species that have greater hearing capabilities and may be sensitive to noise a distances greater than 1 km.



KEY:

- MAREA Study Area
- Mild Behavioural Avoidance Reaction
- Low Likelihood of Disturbance

Dredging Areas

- Licenced Dredging Area
- Licence Renewal Application Area
- Dredging Licence Application Area
- Prospecting Licence Area

Kilometres Travelled

- 0.5 - 100
- 100.1 - 200
- 200.1 - 300
- 300.1 - 400
- 400.1 - 500
- 500.1 - 600
- 600.1 - 700

Porpoises Per Km Travelled

- 0.00330 - 0.030000
- 0.030001 - 0.080000
- 0.080001 - 0.130000
- 0.130001 - 0.180000
- 0.180001 - 0.230000
- 0.230001 - 0.957850

N W E S

0 10

Kilometres

TITLE:

Figure 1.1
Zones of Behavioural Responses of Harbour Porpoises to Dredging Noise

CLIENT: TEDA

DATE: 01/10/2010	CHECKED: VA	PROJECT: 0075577
DRAWN: IG	APPROVED:	SCALE: 1:400,000

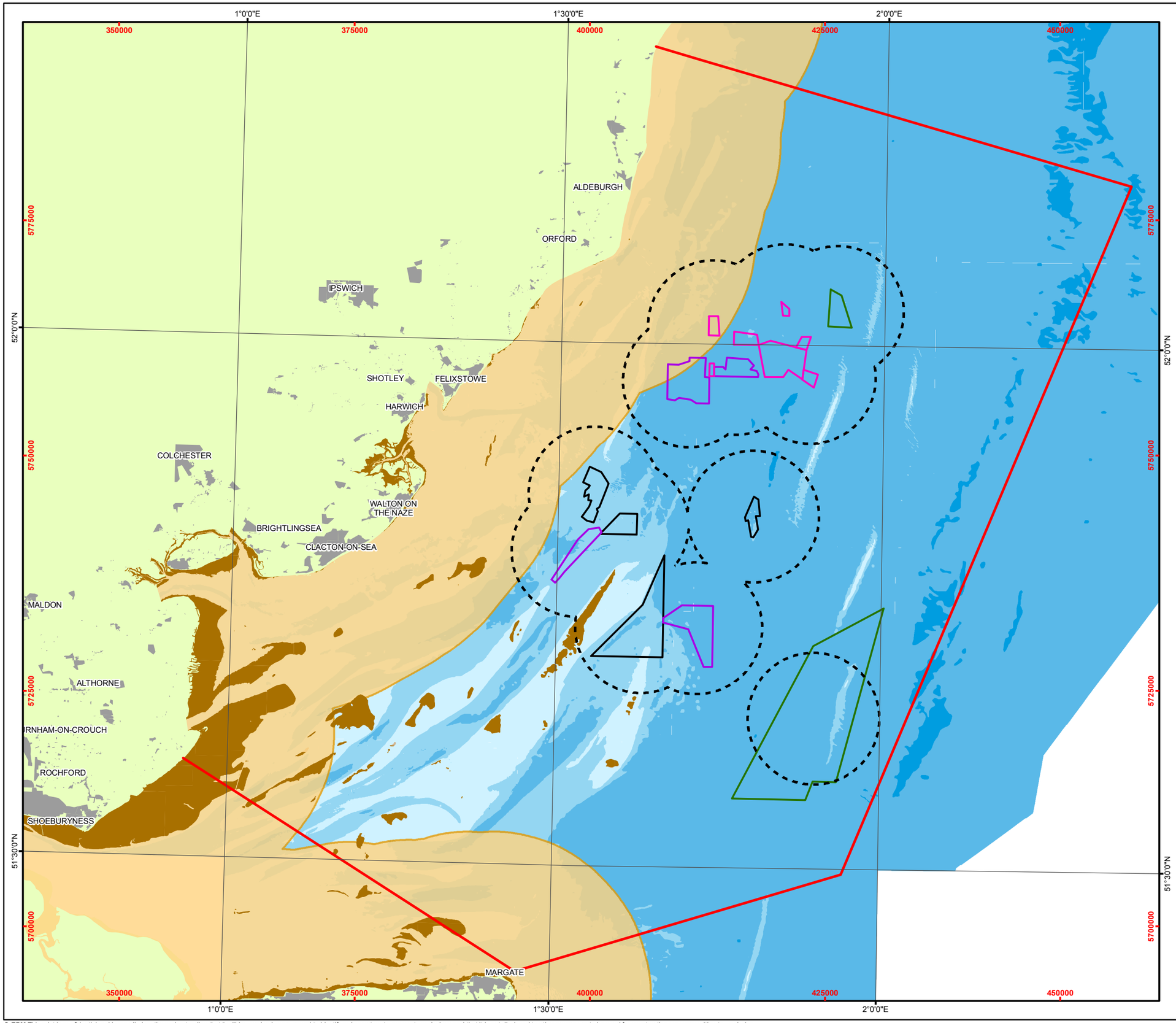
DRAWING: Porpoises_Noise.mxd | REV: 0

ERM
Eaton House
Wallbrook Court
North Hinksey Lane
Oxford, OX2 0QS
Tel: 01865 384800
Fax: 01865 384848

ERM

SOURCE: Seazone Solutions Limited. © Crown copyright, All rights reserved. Shepherd et al (2006). Underwater Noise Impact Assessment on Marine Mammals and Fish during Pile Driving Report.
PROJECTION: WGS 1984 UTM Zone 31N

File: 0075577\EdaREA_GIS_NYL\Maps\FinalFigures_0110\Xcel\Porpoises_Noise.mxd



KEY:

- MAREA Study Area
- Low Likelihood of Disturbance
- Potential Seal Area (sand banks)
- Potential Seal Area (15km from coastline)

Dredging Areas

- Licenced Dredging Area
- Licence Renewal Application Area
- Dredging Licence Application Area
- Prospecting Licence Area

Depth Areas

- Drying
- <=10m
- <=20m
- <=50m
- <=100m

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Kilometres

TITLE: Figure 1.2
Zones of Behavioural Response of Seals to Dredging Noise

CLIENT: TEDA

DATE: 01/10/2010	CHECKED: VA	PROJECT: 0075577
DRAWN: IG	APPROVED:	SCALE: 1:400,000

DRAWING: Seal_Noise.mxd | REV: 0

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Eaton House
Wallbrook Court
North Hinksey Lane
Oxford, OX2 0QS
Tel: 01865 384800
Fax: 01865 384848

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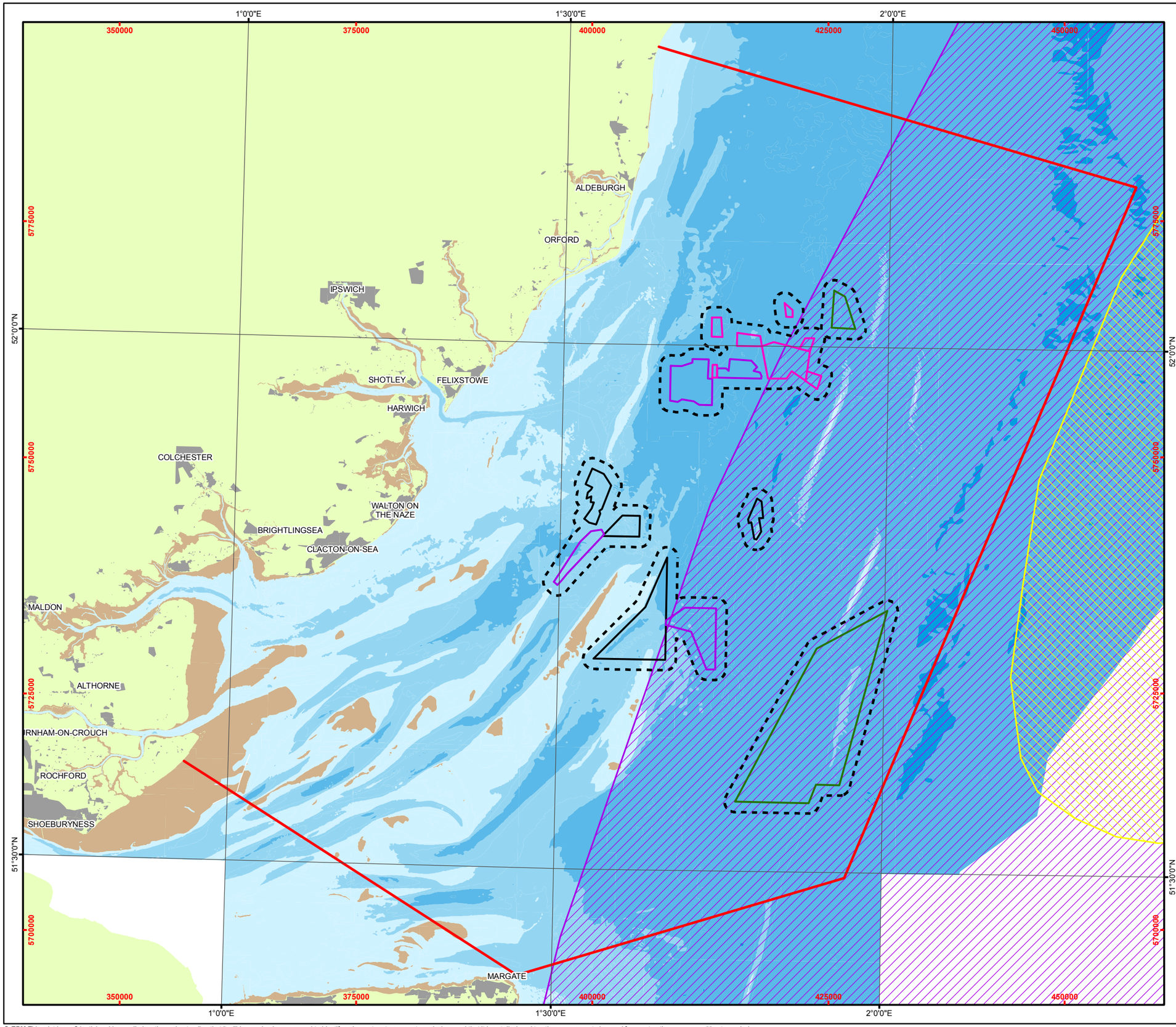
PROJECTION: WGS 1984 UTM Zone 31N

File: 0075577TedaREA_GIS_NYL\Maps\FinalFigures_011010\Seal_Noise.mxd



KEY:

- MAREA Study Area
- Low Likelihood of Disturbance
- Cod Spawning Area
- Cod Nursery Area

Dredging Areas

- Licenced Dredging Area
- Licence Renewal Application Area
- Dredging Licence Application Area
- Prospecting Licence Area

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Kilometres

TITLE:

Figure 1.3
Zones of Behavioural Response of Cod to Dredging Noise

CLIENT:

TEDA

DATE: 01/10/2010	CHECKED: VA	PROJECT: 0075577
DRAWN: IG	APPROVED:	SCALE: 1:400,000

DRAWING: Cod_Noise.mxd | REV: 0

ERM
Eaton House
Wallbrook Court
North Hinksey Lane
Oxford, OX2 0QS
Tel: 01865 384800
Fax: 01865 384848

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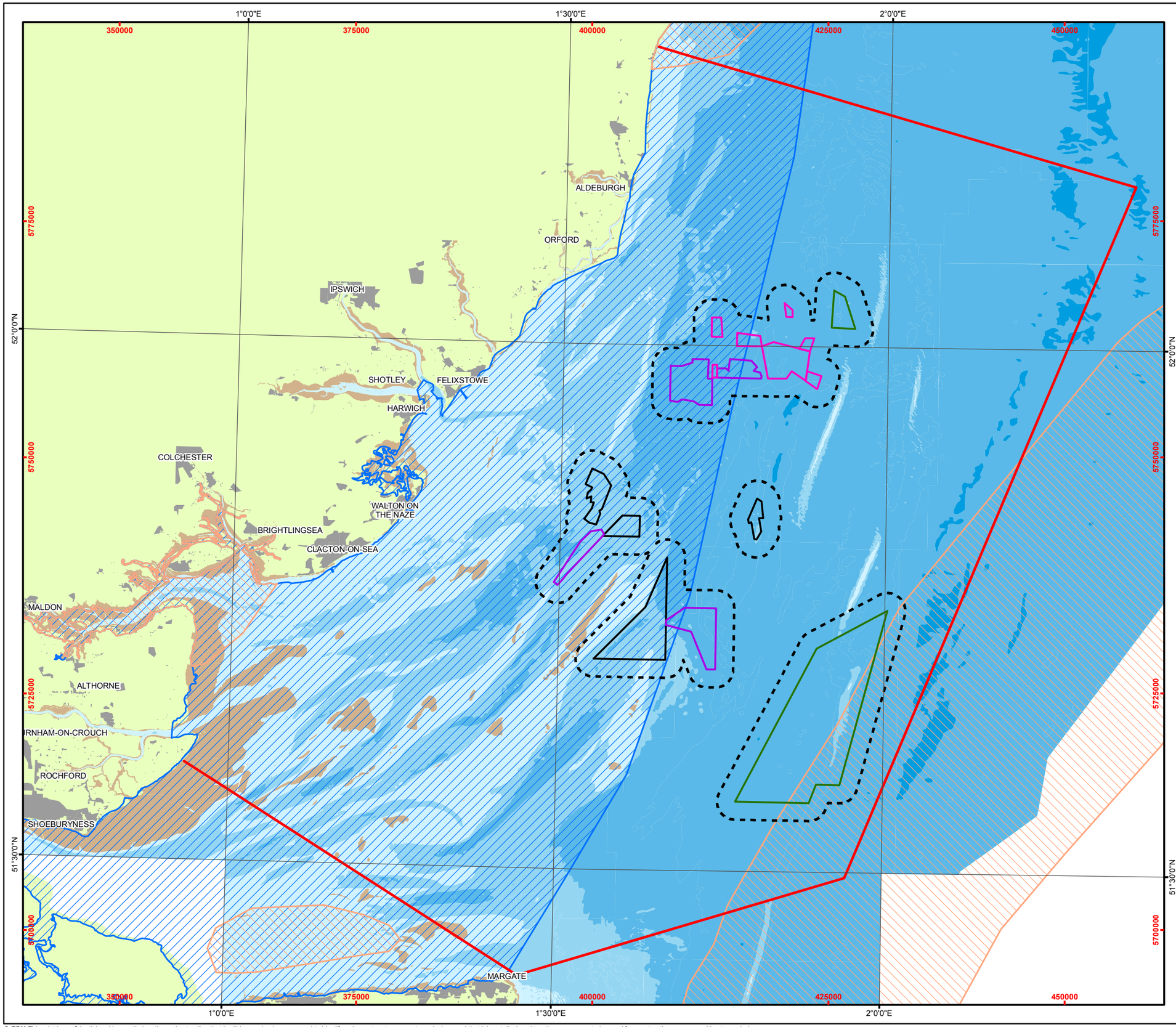
PROJECTION: WGS 1984 UTM Zone 31N

File: 0075577\ReaREA_GIS_NYL\Maps\FinalFigures_0110\Oates\Cod_Noise.mxd



KEY:

- MAREA Study Area
- Low Likelihood of Disturbance
- Herring Spawning Area
- Herring Nursery Area

Dredging Areas

- Licenced Dredging Area
- Licence Renewal Application Area
- Dredging Licence Application Area
- Prospecting Licence Area

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Kilometres

TITLE:

Figure 1.4
Zones of Behavioural Response of Herring to Dredging Noise

CLIENT:
TEDA

DATE: 01/10/2010	CHECKED: VA	PROJECT: 0075577
DRAWN: IG	APPROVED:	SCALE: 1:400,000

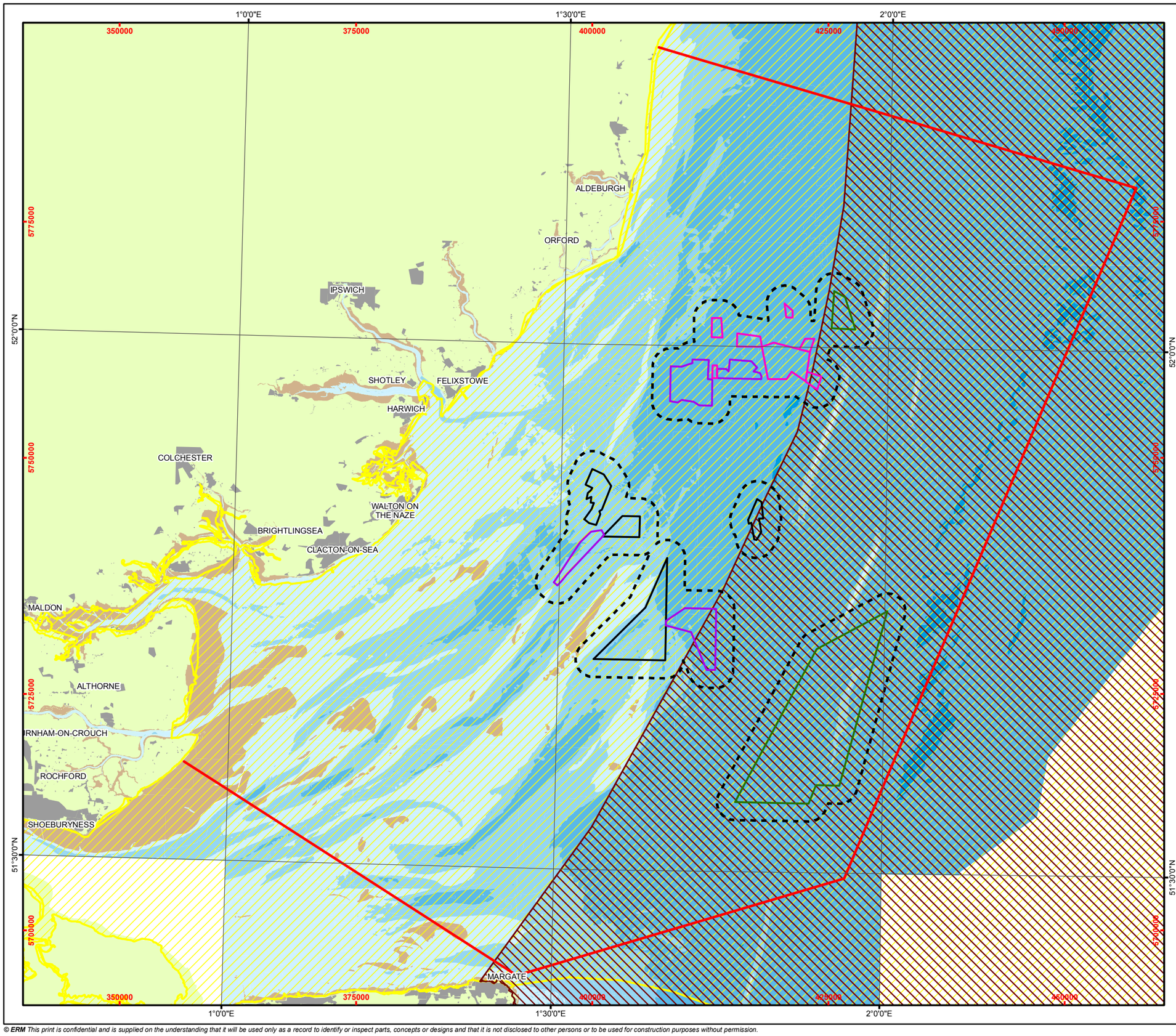
DRAWING: Herring_Noise.mxd | REV: 0

ERM
Eaton House
Wallbrook Court
North Hinksey Lane
Oxford, OX2 0QS
Tel: 01865 384800
Fax: 01865 384848

ERM

PROJECTION: WGS 1984 UTM Zone 31N

File: 0075577\Tedal\REA_GIS_NYL\Maps\FinalFigures_0110\Noise\Herring_Noise.mxd



KEY:

- MAREA Study Area
- Sprat Spawning Area
- Sprat Nursery Area
- Low Likelihood of Disturbance

Dredging Areas

- Licenced Dredging Area
- Licence Renewal Application Area
- Dredging Licence Application Area
- Prospecting Licence Area

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S

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Kilometres

TITLE:

Figure 1.5
Zones of Behavioural Response of Sprat to Dredging Noise

CLIENT: TEDA

DATE: 01/10/2010	CHECKED: VA	PROJECT: 0075577
DRAWN: IG	APPROVED:	SCALE: 1:400,000

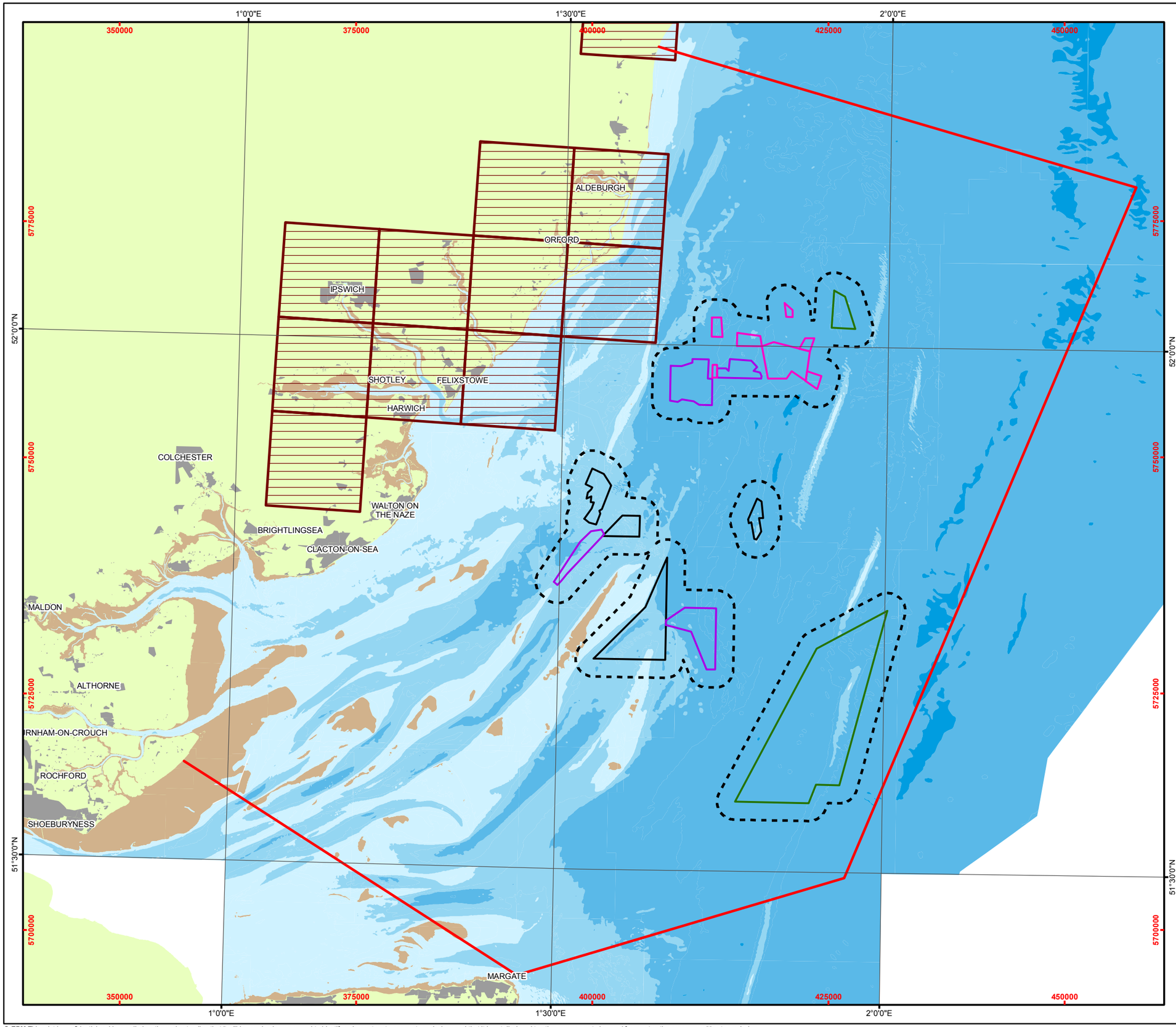
DRAWING: Sprat_Noise.mxd | REV: 0

ERM
Eaton House
Wallbrook Court
North Hinksey Lane
Oxford, OX2 0QS
Tel: 01865 384800
Fax: 01865 384848

ERM

PROJECTION: WGS 1984 UTM Zone 31N

File: 0075577\tedaREA_GIS_NYL\Maps\FinalFigures_0110\Nodes\Sprat_Noise.mxd



KEY:

- MAREA Study Area
- Low Likelihood of Disturbance
- Sea Lamprey

Dredging Areas

- Licenced Dredging Area
- Licence Renewal Application Area
- Dredging Licence Application Area
- Prospecting Licence Area

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Kilometres

TITLE:

Figure 1.6
Zones of Behavioural Response of Sea Lampreys to Dredging Noise

CLIENT: TEDA

DATE: 01/10/2010	CHECKED: VA	PROJECT: 0075577
DRAWN: IG	APPROVED:	SCALE: 1:400,000

DRAWING: SeaLamprey_Noise.mxd | REV: 0

ERM
Eaton House
Wallbrook Court
North Hinksey Lane
Oxford, OX2 0QS
Tel: 01865 384800
Fax: 01865 384848

ERM

PROJECTION: WGS 1984 UTM Zone 31N

File: 0075577\tedaREA_GIS_NYL\Maps\FinalFigures_011010\cdot\SeaLamprey_Noise.mxd

1.5.3 Predicted Behavioural Response Zones: Receptor-Effect Interactions

It should be noted that the results of the predicted zones of behavioural response present the maximum area which could ever be affected by a given behavioural response contour, and to achieve this they assume dredging is occurring continuously throughout the dredging areas up to the licence area limits. In reality, whilst dredging activity may occur at the edge of the licence areas at times, it will generally be focused in one particular zone and in most cases be carried out by one vessel. The actual zones of noise impact at any given time will therefore be much smaller than those shown in *Figure 1.2* to *Figure 1.7*.

In addition the behavioural response zones are only applicable during times when dredging activity is occurring. On average, there will be approximately 5.2 vessel trips per day spread over the 19 dredging areas.

Where two dredging areas are in close proximity, dredger noise may combine to produce a greater overall noise level and associated impact. This occurrence is likely to be infrequent and short-lived however.

1.5.4 Magnitude of Effect

Figures 1.4-1.7 show that for all of the fish species, dredging noise is a **local** impact. For the marine mammal species (harbour porpoise, common seal and grey seal) the cumulative impact extends to cover much of the MAREA area and is therefore a **sub-regional** impact. In terms of frequency, the effect is a **routine** effect that occurs during all dredging operations, however in terms of duration, the effect is **temporary** and stops immediately following cessation of dredging.

Consequently, at the regional scale the effect of dredging noise on marine mammals are considered to be a **medium magnitude** effect, while the effect of dredging noise on fish is a **low-medium magnitude** effect.

1.5.5 Receptor Sensitivity

The spatial extent of the behavioural impact zones is considered as part of the effect magnitude characterisation (*Section 1.5.3*). The sensitivity of the receptors is then determined from the species' adaptability, tolerance and ability to recover in relation to the given effect. In the case of underwater noise, given that the impact is a temporary avoidance reaction, receptor sensitivity depends predominantly on the reliance of the species on specific sites that are within the predicted zones of behavioural response.

Consequently species that have a high reliance on haul out sites or specific spawning areas, or which migrate within a narrow corridor will generally be more sensitive to the effects of underwater noise than species that utilise a wide range of habitats. The sensitivity of each receptor is discussed in the sections below.

1.5.6 Impact Significance

Introduction

The potential regional impacts for each species under consideration are summarised under the following headings below:

- Cetaceans;
- Pinnipeds;
- Elasmobranchs;
- Demersal Fish;
- Pelagic Fish; and
- Migratory Fish.

As with any prediction of the impacts of underwater noise on fish and marine mammals, there are significant uncertainties. The greatest uncertainties are derived from the existing data on the sensitivity of various species to noise and also on the attenuation of noise due to propagation through the water. As such, the findings of this report provide an estimate of the effects that may arise from dredging activities in the outer Thames Estuary MAREA study area based on a reasonable worst-case scenario taking account of existing data and research.

Cetaceans

Harbour porpoise may be found throughout the study area. Behavioural responses due to noise from the dredging activities may occur at up to approximately 5 km from dredging vessels, but within this zone there is considered to be a 'low likelihood of disturbance'. Mild behavioural reactions are expected within 2 km of dredging vessels, and strong reactions within 500 m; as described above, the effect of noise on marine mammals is considered to be a **medium magnitude** effect. Harbour porpoise is a **high value** receptor, however this species is highly mobile and capable of avoiding noise disturbances caused by dredging; it is therefore considered to have high tolerance and adaptability (ie **low sensitivity**).

The proportion of the study area which will be subject to noise disturbance at the 'mild behavioural reactions' threshold from any single dredger is very small relative to the total available habitat for the species (12.6 km^2 out of a total available area of 5520 km^2 in the MAREA study area, or 0.22%). However, as explained in *Section 1.5.2* this assessment is based on the assumption that dredging takes place throughout each licence area at all times, and when the potentially impacted areas around all of the licence areas are considered together (as shown in *Figure 1.2*) the area covered represents 15% of the habitat available in the Thames region. Based on this assumption the cumulative impact of dredging noise on this species is assessed to be of ***moderate significance*** at the regional scale.

In practice, this level of dredging is clearly not possible, not least because it

would require a fleet of at least 65 vessels. However, as it is not possible for TEDA member companies to specify the maximum numbers of dredgers within each licence area at the present time, this is the only scenario that can be assessed within the MAREA. Consequently it is expected that during the licence-specific EIAs, when the maximum numbers of vessels per licence area has been defined and the licence areas have been provisionally zoned, the predicted potential impact to harbour porpoise will be considerably lower than stated here.

Pinnipeds

Common seals are mostly found on sandbanks and haul-outs close to the coast. Some suitable areas in the vicinity of application area 452 and licence areas 118/2, 239/1, 447, 108/1, 257 and 119/3 fall within the boundary of a 'low likelihood of disturbance'. However this level of potential impact is not thought to be significant. Mild and strong behavioural reactions are expected within 500 m and 70 m respectively of dredgers active in Areas 452A and 118/2. Underwater noise from dredging is therefore considered to be a **low-medium magnitude** effect. The receptor is assessed as being of **high value** and of **medium sensitivity** due to its use of specific haul-out sites in the study area, particularly when pupping. Again the potentially impacted area constitutes a very small proportion of the study area which this species is thought to inhabit. The cumulative impact of dredging noise on the species is therefore considered to be of ***minor significance***.

Grey seals may be found within similar areas to common seals and may therefore be similarly impacted. However they are known to prefer rocky coastlines and are found in lower numbers within the MAREA area than common seals. However on the basis of the available data, a conservative approach is taken and the same impact assessment criteria as applied to the common seal are used. The cumulative impact of dredging noise on the species is therefore also considered to be of ***minor significance***.

Migratory Fish

Sea lampreys are highly active migratory fish, capable of moving widely throughout the Thames Estuary and surrounding area (1). They are predicted to react to dredging noise at a distance up to 1.9 km from a dredging vessel, with mild behavioural reactions expected within 60 m of dredgers, and strong reactions within 6 m. The magnitude of this impact is therefore assessed as being **low**. A precautionary approach has been taken to this **high** value species in the absence of any species-specific data so it has been assessed as having **medium-high** sensitivity to underwater noise. However the proportion of the study area within which behavioural responses are predicted to occur is a **very small** proportion of the overall available habitat for this species. Behavioural reactions (eg avoidance behaviour) within the licence areas are not anticipated to have any impact on ecologically important

(1) Maitland, P. S. 2003. *Ecology of the River, Brook and Sea Lamprey*. Conserving Natura 2000 Rivers Ecology Series No 5. English Nature, Peterborough.

behaviours (such as migration, reproduction or feeding) in this species. The cumulative impact of dredging noise on the species is therefore considered to be ***not significant***.

Demersal Fish

Sole are likely to be distributed throughout the study area. Due to their low hearing capability they are only expected to react to dredging noise within 130 m of a vessel at the most, with strong responses occurring within less than 1 m from the dredging vessels, and mild reactions within 3 m. The zones of behavioural response do not interact with the important sole nursery areas around the coast or at the mouth of the Thames Estuary and the proportion of the study area within which behavioural responses are predicted to occur at any given time is a very small proportion of the overall distribution of this species in the region. Consequently the degree of regional interaction is **very small,** the receptor is **low sensitivity** and the magnitude of the effect is **low**. The cumulative impact of dredging noise on this **medium-high** value species is therefore considered to be ***not significant***.

Cod may be found throughout the study area at all times of year. Behavioural responses due to noise from dredging activities may occur up to approximately 1.1 km from dredging vessels, with mild behavioural reactions expected within 30 m of dredgers and strong reactions within 4 m. In the case of some licence areas the zones of mild and strong behavioural response overlap with cod spawning or nursery grounds in the region, however the cumulative area that may potentially be impacted is a small proportion of the available spawning and nursery ground in the Outer Thames. The degree of interaction at the regional scale is therefore **small,** the species is a **high value** receptor of **low-medium sensitivity** and the magnitude of the effect is **low**. The cumulative impact of dredging noise on cod is therefore considered to be of ***minor significance***.

Pelagic Fish

Herring occur throughout the study area. Behavioural responses due to noise from dredging activities may occur up to approximately 1.9 km from dredging vessels with mild behavioural reactions expected within 60 m of dredgers, and strong reactions within 6 m, therefore the magnitude of the impact is **low**. Herring are a **high sensitivity** receptor because they have well-developed hearing for a fish species and require the gravel sediments that are often found within aggregate licence areas for spawning; as such they have low adaptability and medium tolerance, coupled with low-medium ability to recover due to the currently poor status of the North Sea herring stock.

Noise disturbance from the North Falls prospecting area may impact on a small proportion of a large offshore potential herring spawning area; this will be a consideration at the EIA stage for this licence area but in the context of the available habitat in the region, the degree of interaction is **very small** and there are no cumulative effects with other licence areas. The locally important

spawning areas within the Blackwater estuary are not within the predicted zones of behavioural response for any of the licence areas. However, for some licence areas, particularly those in the east of the study area, the potential area of mild and strong reactions to noise disturbance overlaps with herring nursery areas. Overall the cumulative impact of dredging noise on herring is therefore considered to be of ***minor significance***.

As with herring, **sprat** are predicted to react to dredging noise at a distance up to 1.9 km from a dredging vessel, with mild behavioural reactions expected within 60 m of dredgers, and strong reactions within 6 m, therefore the magnitude of the impact is assessed as being **low**. This **medium** value receptor has a **medium** sensitivity to noise disturbance; like herring it is a hearing specialist, but it does not have specific habitat requirements like herring. Sprat spawning and nursery grounds extend through much of the North Sea and consequently all of the licence areas overlap with potential sprat nursery areas in the region and many overlap with the sprat spawning area. The area of available habitat within which mild or strong behavioural reactions could potentially occur constitutes a **very small** proportion of available habitat at a regional scale. The cumulative impact of dredging noise on the species is therefore considered to be of ***minor significance***.

Elasmobranchs

Thornback rays may be found throughout the study area. However, due to their low hearing capability, behavioural responses due to noise from dredging activities may occur at up to approximately 130 m from dredging vessels, with strong responses occurring within less than 1 m from the dredging vessels, and mild reactions within 3 m. The proportion of the study area within which mild or strong behavioural responses are predicted to occur at any given time is an extremely small proportion of the overall feeding areas available to this species in the region. The degree of regional interaction is therefore **very small**, the effect magnitude is **low** and the receptor sensitivity is **low** so although the receptor value is **medium-high**, the cumulative impact of dredging noise on the species is considered to be ***not significant***.

1.5.7 Licence-Specific Receptor-Effect Interactions

Annex A presents the predicted effects in terms of behavioural responses of marine mammal and fish species important in the outer Thames Estuary MAREA area, to noise from dredging activities in each individual licence area. This is based on an analysis of to what extent the predicted zone of behavioural response to dredging noise overlaps with the presence of the species (in the case of the marine mammals) or the distribution of their ecologically important habitats eg spawning and nursery areas or migratory corridors (in the case of important fish species) (see *Figure 1.2* to *Figure 1.7*).

Again it should be noted that the assessment is based on the assumption that dredging will take place continuously throughout the dredging areas up to the licence area limits. In reality dredging will be focused in one zone and in

most cases be carried out by one vessel, therefore the actual noise impact zones will be much smaller than those shown in the figures.

1.6 ASSESSMENT OF VIBRATION IMPACTS DUE TO DREDGING ACTIVITIES

As part of the Hastings study, seabed vibration measurements were taken at a distance of 509 m to 719 m from the dredging operation. The data indicate RMS (root mean square) seabed vibration magnitudes varied between a mean of 0.0018 $mm.s^{-1}$ at a range of 509 m, to 0.0011 $mm.s^{-1}$ at 719 m. The peak to peak seabed vibration magnitudes over this measurement range were less than 0.1 $mm.s^{-1}$

Aicher *et al* (1983) (1) carried out studies looking at the vibration sensitivity of crabs, specifically the fiddler crab (*Uca pugilator*), which uses vibration (in the form of drumming their claws), as a means of communication during courtship. They found that substrate-borne vibration signals play an important role. The study investigated how a vibration in a substrate is transmitted through the legs and body of a freely standing live crab, measuring the motion of the substrate and dactylopodite, carpopodite, meropodite and carapax of the crab. The output motion was compared with the input motion to determine the transfer function at each of the measured points. During the pulse train phase of the experiment, the stimulus involved discrete pulses each at a peak velocity of 300 $mm.s^{-1}$. Although the study was not specifically investigating threshold or supra-threshold vibration response levels for the fiddler crab, the stimulus levels used in these tests provide some indication of the level of ground vibration required for sensing.

It may be concluded that the low levels of seabed vibration produced by dredging measured at a distance of approximately 500 m, are unlikely to cause a disturbance to species of crab. Data relating to the sensitivity of other benthic species to vibration is unavailable at present; however they would have to be significantly more sensitive to vibration than the fiddler crab for significant impacts to occur.

1.7 IN COMBINATION IMPACTS

Ambient underwater noise levels in the TEDA study area are likely to be high at present due to the high volumes of shipping traffic and construction of offshore wind farms, as discussed in the baseline section (*Section 1.1*).

Ongoing wind farm construction and an increased number of deeper draughted and longer container ships passing through the study area, as a result of the construction of the London Gateway deepwater port within the river Thames (the first three berths are to be constructed by 2012) and the

(1) Aicher, B. Markl, H. Masters M. Kirschenlohr, H. 1983. Vibration transmission through the walking legs of the fiddler crab, Uca pugilator (Brachyura, Ocypodidae) as measured by Laser Doppler Vibrometry. Journal of Comparative Physiology A: Neuroethology, Sensory, Neural, and Behavioral Physiology. 150: 483 – 491

Felixstowe port enhancement (completion expected 2014), will lead to increased noise levels in the Thames region.

Where new or increased noise sources are situated close to dredging sites, they may have the effect of masking noise from dredging operations, effectively reducing the contribution of dredging to overall noise levels. Dredging noise in other areas that are currently quieter, however, may have an additive effect at the regional scale with increased noise levels at one or more other developments in the region. An increase in noise levels in a number of areas across the region may have the effect of reducing the area of suitable habitat for some species within which no behavioural response will occur. For some particularly sensitive species this regional in-combination impact could be significant; potential interactions that should be considered in site specific EIAs are identified in the in-combination section of the MAREA.

1.8 CONCLUSION/SUMMARY

The potential effects of dredging noise on key species of marine animals have been estimated based on the findings from the assessment of underwater noise from dredging operations on the Hastings Shingle Bank.

This study has indicated that any effect from underwater noise due to dredging activity is likely to be behavioural, and limited to the immediate vicinity of the dredging operations.

Noise levels in some licence areas as a result of dredging operations may produce behavioural responses where certain key species of marine animals are likely to be present close by. However in the case of all species studied, with the exception of the particularly sensitive harbour porpoise, impacts from noise are considered to be minor, as a result of the areas that may potentially be impacted by noise being very small in the context of the wide distribution of these species and their habitats throughout the Outer Thames. Actual levels of impact will also depend on the level of ambient (baseline) noise in that area.

Impacts on harbour porpoise are considered to be moderate, based on the assumption that dredging takes place throughout each licence area at all times. However this level of dredging is not realistic and it is likely that during licence-specific EIAs, when the maximum number of vessels per licence area has been defined and the licence areas have been provisionally zoned, the predicted potential impact to harbour porpoise will be considerably lower than stated here.

It has been concluded that the low levels of seabed vibration produced by dredging operations are unlikely to cause a disturbance to species of crab. Other benthic species would have to be significantly more sensitive to vibration than the fiddler crab for significant impacts to occur.

It should be noted that this assessment has been based on the assumption that dredging could occur throughout all of the licence areas at any one time. In reality, potential noise impacts from dredging activity will be limited by the maximum number of boats available to work in the region at any one time, and the actual time the vessels can spend dredging on the licence. For example it is likely that there will only be a few cargoes from each licence area per week with a dredging time per cargo of approximately 4 hours.

Cumulative and in combination factors such as the current baseline activities, wind farm construction and the expected increase in future shipping traffic are likely to increase future noise levels.

Annex A

Likely Behavioural Responses Due to Dredging Noise

Table A.1 Likely Behavioural Responses Due to Dredging Noise

Dredging Area	Harbour Porpoise	Harbour / Grey Seal	Thornback ray	Sole	Cod	Whiting	Herring	Sprat	Lampreys
Area 452 A	Harbour porpoise may be located in this area and may be disturbed within 5 km of dredging vessels. Mild behavioural reactions are expected within 2 km; strong reactions within 500m. There is therefore potential for harbour porpoise to be displaced as a result of dredging in this licence area.	The licence area is within the coastal area that is predicted to be an important habitat for seals. Mild behavioural reactions are expected within 500 m of dredging vessels; strong reactions within 70m. There is therefore potential for foraging seals to be disturbed as a result of dredging in this licence area.	Thornback ray spawn throughout the outer Thames and their distribution overlaps with the areas of behavioural response which may occur up to 130m from a dredging vessel. However the licence area is a long distance from the main spawning area and mild reactions are only expected within 3m and a strong reaction within just 1m of the vessel. These factors mean that any disturbance will be extremely limited.	Sole are distributed throughout the area and the Thames Estuary is an important spawning ground. Sole may therefore be present within the zones of behavioural response to dredging noise (up to 130m from a dredger). Potentially sensitive sole nursery areas are located near the coast, outside the zone of behavioural response. This, together with the low hearing ability of the species means that any disturbance will be extremely limited.	Cod are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which cod may be displaced represents a very small proportion of the total habitat available.	Whiting are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which whiting may be displaced represents a very small proportion of the total habitat available.	Herring are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. All 3 behavioural impact contours from this licence area overlap with the important herring nursery area in the region therefore juvenile herring may potentially be impacted.	Sprat are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance, mild and strong behavioural response contours. Sprat spawning and nursery areas extend across much of the southern North Sea and sprat do not have the same specific habitat requirements as other species. The area of available habitat within which mild or strong behavioural reactions from dredging in this area could potentially occur constitutes a very small proportion of available habitat.	Sea lampreys are capable of moving over large areas throughout the Outer Thames and therefore their distribution may overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. There is a low likelihood of river lamprey presence within the area of predicted behavioural response, due to their predominantly coastal presence during migration.
Consider at EIA?	Yes	Yes	No	No	No	No	Yes	No	No
Area 452 B	Harbour porpoise may be located in this area and may be disturbed within 5 km of dredging vessels. Mild behavioural reactions are expected within 2 km; strong reactions within 500m. There is therefore potential for harbour porpoise to be displaced as a result of dredging in this licence area.	Some populated areas fall within the boundary of a low likelihood of disturbance from this licence area (7km) but none are within the predicted area of mild or strong behavioural reactions. No significant disturbance to foraging seals is therefore anticipated.	Thornback ray spawn throughout the outer Thames and their distribution overlaps with the areas of behavioural response which may occur up to 130m from a dredging vessel. However the licence area is a long distance from the main spawning area and mild reactions are only expected within 3m and a strong reaction within just 1m of the vessel. These factors mean that any disturbance will be extremely limited.	Sole are distributed throughout the area and the Thames Estuary is an important spawning ground. Sole may therefore be present within the zones of behavioural response to dredging noise (up to 130m from a dredger). Potentially sensitive sole nursery areas are located near the coast, outside the zone of behavioural response. This, together with the low hearing ability of the species means that any disturbance will be extremely limited.	Cod are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which cod may be displaced represents a very small proportion of the total habitat available.	Whiting are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which whiting may be displaced represents a very small proportion of the total habitat available.	Herring are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. All 3 behavioural impact contours from this licence area overlap with the important herring nursery area in the region therefore juvenile herring may potentially be impacted.	Sprat are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance, mild and strong behavioural response contours. Sprat spawning and nursery areas extend across much of the southern North Sea and sprat do not have the same specific habitat requirements as other species. The area of available habitat within which mild or strong behavioural reactions from dredging in this area could potentially occur constitutes a very small proportion of available habitat.	Sea lampreys are capable of moving over large areas throughout the Outer Thames and therefore their distribution may overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. There is a low likelihood of river lamprey presence within the area of predicted behavioural response, due to their predominantly coastal presence during migration.
Consider at EIA?	Yes	No	No	No	No	No	Yes	No	No
Area 452 C	Harbour porpoise may be located in this area and may be disturbed within 5 km of dredging vessels. Mild behavioural reactions are expected within 2 km; strong reactions within 500m. There is therefore potential for harbour porpoise to be displaced as a result of dredging in this licence area.	Seal distribution overlaps with a very small proportion of the low likelihood of disturbance contour (7km) from Area 452 C1. The distribution of seals does not overlap with the zones of behavioural response from Areas 452 C2 or C3. No strong or mild reactions are expected from dredging in any part of Area 452 C. No significant disturbance to foraging seals is therefore anticipated.	Thornback ray spawn throughout the outer Thames and their distribution overlaps with the areas of behavioural response which may occur up to 130m from a dredging vessel. However the licence area is a long distance from the main spawning area and mild reactions are only expected within 3m and a strong reaction within just 1m of the vessel. These factors mean that any disturbance will be extremely limited.	Sole are distributed throughout the area and the Thames Estuary is an important spawning ground. Sole may therefore be present within the zones of behavioural response to dredging noise (up to 130m from a dredger). Potentially sensitive sole nursery areas are located near the coast, outside the zone of behavioural response. This, together with the low hearing ability of the species means that any disturbance will be extremely limited.	Cod are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is overlap of all these contours with the cod nursery area, therefore there is a potential for juvenile cod to be impacted.	Whiting are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is overlap of all these contours with the main whiting spawning area in the southern North Sea, therefore there is a potential for whiting reproduction to be impacted.	Herring are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. However, there is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which herring may be displaced represents a very small proportion of the total habitat available.	Sprat are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance, mild and strong behavioural response contours. Sprat spawning and nursery areas extend across much of the southern North Sea and sprat do not have the same specific habitat requirements as other species. The area of available habitat within which mild or strong behavioural reactions from dredging in this area could potentially occur constitutes a very small proportion of available habitat.	Sea lampreys are capable of moving over large areas throughout the Outer Thames and therefore their distribution may overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. There is a low likelihood of river lamprey presence within the area of predicted behavioural response, due to their predominantly coastal presence during migration.
Consider at EIA?	Yes	No	No	No	Yes	Yes	No	No	No

Dredging Area	Harbour Porpoise	Harbour / Grey Seal	Thornback ray	Sole	Cod	Whiting	Herring	Sprat	Lampreys
Area 452 D	Harbour porpoise may be located in this area and may be disturbed within 5 km of dredging vessels. Mild behavioural reactions are expected within 2 km; strong reactions within 500m. There is therefore potential for harbour porpoise to be displaced as a result of dredging in this licence area.	The distribution of seals does not overlap with the zones of behavioural response. No behavioural responses to dredging in this licence area are expected.	Thornback ray spawn throughout the outer Thames and their distribution overlaps with the areas of behavioural response which may occur up to 130m from a dredging vessel. However the licence area is a long distance from the main spawning area and mild reactions are only expected within 3m and a strong reaction within just 1m of the vessel. These factors mean that any disturbance will be extremely limited.	Sole are distributed throughout the area and the Thames Estuary is an important spawning ground. Sole may therefore be present within the zones of behavioural response to dredging noise (up to 130m from a dredger). Potentially sensitive sole nursery areas are located near the coast, outside the zone of behavioural response. This, together with the low hearing ability of the species means that any disturbance will be extremely limited.	Cod are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is very slight overlap of the low likelihood of disturbance contour with the cod nursery area, but no overlap of the strong or mild reaction contours. As such no impacts to juvenile cod are expected and the area of feeding habitat from which adult cod may be displaced represents a very small proportion of the total habitat available.	Whiting are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which whiting may be displaced represents a very small proportion of the total habitat available.	Herring are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. However, there is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which herring may be displaced represents a very small proportion of the total habitat available.	Sprat are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance, mild and strong behavioural response contours. Sprat spawning and nursery areas extend across much of the southern North Sea and sprat do not have the same specific habitat requirements as other species. The area of available habitat within which mild or strong behavioural reactions from dredging in this area could potentially occur constitutes a very small proportion of available habitat.	Sea lampreys are capable of moving over large areas throughout the Outer Thames and therefore their distribution may overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. There is a low likelihood of river lamprey presence within the area of predicted behavioural response, due to their predominantly coastal presence during migration.
Consider at EIA?	Yes	No	No	No	No	No	No	No	No
Area 452 E	Harbour porpoise may be located in this area and may be disturbed within 5 km of dredging vessels. Mild behavioural reactions are expected within 2 km; strong reactions within 500m. There is therefore potential for harbour porpoise to be displaced as a result of dredging in this licence area.	Some populated areas fall within the boundary of a low likelihood of disturbance from this licence area (7km) but none are within the predicted area of mild or strong behavioural reactions. No significant disturbance to foraging seals is therefore anticipated.	Thornback ray spawn throughout the outer Thames and their distribution overlaps with the areas of behavioural response which may occur up to 130m from a dredging vessel. However the licence area is a long distance from the main spawning area and mild reactions are only expected within 3m and a strong reaction within just 1m of the vessel. These factors mean that any disturbance will be extremely limited.	Sole are distributed throughout the area and the Thames Estuary is an important spawning ground. Sole may therefore be present within the zones of behavioural response to dredging noise (up to 130m from a dredger). Potentially sensitive sole nursery areas are located near the coast, outside the zone of behavioural response. This, together with the low hearing ability of the species means that any disturbance will be extremely limited.	Cod are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which cod may be displaced represents a very small proportion of the total habitat available.	Whiting are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which whiting may be displaced represents a very small proportion of the total habitat available.	Herring are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. All 3 behavioural impact contours from this licence area overlap with the important herring nursery area in the region therefore juvenile herring may potentially be impacted.	Sprat are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance, mild and strong behavioural response contours. Sprat spawning and nursery areas extend across much of the southern North Sea and sprat do not have the same specific habitat requirements as other species. The area of available habitat within which mild or strong behavioural reactions from dredging in this area could potentially occur constitutes a very small proportion of available habitat.	Sea lampreys are capable of moving over large areas throughout the Outer Thames and therefore their distribution may overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. There is a low likelihood of river lamprey presence within the area of predicted behavioural response, due to their predominantly coastal presence during migration.
Consider at EIA?	Yes	No	No	No	No	No	Yes	No	No
North Inner Gabbard	Harbour porpoise may be located in this area and may be disturbed within 5 km of dredging vessels. Mild behavioural reactions are expected within 2 km; strong reactions within 500m. There is therefore potential for harbour porpoise to be displaced as a result of dredging in this licence area.	The distribution of seals does not overlap with the zones of behavioural response. No behavioural responses to dredging in this licence area are expected.	Thornback ray spawn throughout the outer Thames and their distribution overlaps with the areas of behavioural response which may occur up to 130m from a dredging vessel. However the licence area is a long distance from the main spawning area and mild reactions are only expected within 3m and a strong reaction within just 1m of the vessel. These factors mean that any disturbance will be extremely limited.	Sole are distributed throughout the area and the Thames Estuary is an important spawning ground. Sole may therefore be present within the zones of behavioural response to dredging noise (up to 130m from a dredger). Potentially sensitive sole nursery areas are located near the coast, outside the zone of behavioural response. This, together with the low hearing ability of the species means that any disturbance will be extremely limited.	Cod are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is overlap of all these contours with the cod nursery area, therefore there is a potential for juvenile cod to be impacted.	Whiting are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is overlap of all these contours with the main whiting spawning area in the southern North Sea, therefore there is a potential for whiting reproduction to be impacted.	Herring are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. However, there is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which herring may be displaced represents a very small proportion of the total habitat available.	Sprat are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance, mild and strong behavioural response contours. Sprat spawning and nursery areas extend across much of the southern North Sea and sprat do not have the same specific habitat requirements as other species. The area of available habitat within which mild or strong behavioural reactions from dredging in this area could potentially occur constitutes a very small proportion of available habitat.	Sea lampreys are capable of moving over large areas throughout the Outer Thames and therefore their distribution may overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. There is a low likelihood of river lamprey presence within the area of predicted behavioural response, due to their predominantly coastal presence during migration.
Consider at EIA?	Yes	No	No	No	Yes	Yes	No	No	No

Dredging Area	Harbour Porpoise	Harbour / Grey Seal	Thornback ray	Sole	Cod	Whiting	Herring	Sprat	Lampreys
North Falls	Harbour porpoise may be located in this area and may be disturbed within 5 km of dredging vessels. Mild behavioural reactions are expected within 2 km; strong reactions within 500m. There is therefore potential for harbour porpoise to be displaced as a result of dredging in this licence area.	The distribution of seals does not overlap with the zones of behavioural response. No behavioural responses to dredging in this licence area are expected.	Thornback ray spawn throughout the outer Thames and their distribution overlaps with the areas of behavioural response which may occur up to 130m from a dredging vessel. However the licence area is a long distance from the main spawning area and mild reactions are only expected within 3m and a strong reaction within just 1m of the vessel. These factors mean that any disturbance will be extremely limited.	Sole are distributed throughout the area and the Thames Estuary is an important spawning ground. Sole may therefore be present within the zones of behavioural response to dredging noise (up to 130m from a dredger). Potentially sensitive sole nursery areas are located near the coast, outside the zone of behavioural response. This, together with the low hearing ability of the species means that any disturbance will be extremely limited.	Cod are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is overlap of all these contours with the cod nursery area, therefore there is a potential for juvenile cod to be impacted.	Whiting are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is overlap of all these contours with the main whiting spawning area in the southern North Sea, therefore there is a potential for whiting reproduction to be impacted.	Herring are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. All three contours overlap with herring spawning area along the eastern edge of this prospecting area. Herring require a very specific combination of environmental conditions in their spawning grounds, and any disturbance that displaces them from these areas has the potential to impact reproductive success.	Sprat are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance, mild and strong behavioural response contours. Sprat spawning and nursery areas extend across much of the southern North Sea and sprat do not have the same specific habitat requirements as other species. The area of available habitat within which mild or strong behavioural reactions from dredging in this area could potentially occur constitutes a very small proportion of available habitat.	Sea lampreys are capable of moving over large areas throughout the Outer Thames and therefore their distribution may overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. There is a low likelihood of river lamprey presence within the area of predicted behavioural response, due to their predominantly coastal presence during migration.
Consider at EIA?	Yes	No	No	No	Yes	Yes	Yes	No	No
118 / 2	Harbour porpoise may be located in this area and may be disturbed within 5 km of dredging vessels. Mild behavioural reactions are expected within 2 km; strong reactions within 500m. There is therefore potential for harbour porpoise to be displaced as a result of dredging in this licence area.	The licence area is within the coastal area that is predicted to be an important habitat for seals. Mild behavioural reactions are expected within 500 m of dredging vessels; strong reactions within 70m. There is therefore potential for foraging seals to be disturbed as a result of dredging in this licence area.	Thornback ray spawn throughout the outer Thames and their distribution overlaps with the areas of behavioural response which may occur up to 130m from a dredging vessel. However the licence area is a long distance from the main spawning area and mild reactions are only expected within 3m and a strong reaction within just 1m of the vessel. These factors mean that any disturbance will be extremely limited.	Sole are distributed throughout the area and the Thames Estuary is an important spawning ground. Sole may therefore be present within the zones of behavioural response to dredging noise (up to 130m from a dredger). Potentially sensitive sole nursery areas are located near the coast, outside the zone of behavioural response. This, together with the low hearing ability of the species means that any disturbance will be extremely limited.	Cod are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which cod may be displaced represents a very small proportion of the total habitat available.	Whiting are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which whiting may be displaced represents a very small proportion of the total habitat available.	Herring are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. All 3 behavioural impact contours from this licence area overlap with the important herring nursery area in the region therefore juvenile herring may potentially be impacted.	Sprat are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance, mild and strong behavioural response contours. Sprat spawning and nursery areas extend across much of the southern North Sea and sprat do not have the same specific habitat requirements as other species. The area of available habitat within which mild or strong behavioural reactions from dredging in this area could potentially occur constitutes a very small proportion of available habitat.	Sea lampreys are capable of moving over large areas throughout the Outer Thames and therefore their distribution may overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. There is a low likelihood of river lamprey presence within the area of predicted behavioural response, due to their predominantly coastal presence during migration.
Consider at EIA?	Yes	Yes	No	No	No	No	Yes	No	No
239 / 1	Harbour porpoise may be located in this area and may be disturbed within 5 km of dredging vessels. Mild behavioural reactions are expected within 2 km; strong reactions within 500m. There is therefore potential for harbour porpoise to be displaced as a result of dredging in this licence area.	Some populated areas fall within the boundary of a low likelihood of disturbance from this licence area (7km) but none are within the predicted area of mild or strong behavioural reactions. No significant disturbance to foraging seals is therefore anticipated.	Thornback ray spawn throughout the outer Thames and their distribution overlaps with the areas of behavioural response which may occur up to 130m from a dredging vessel. However the licence area is a long distance from the main spawning area and mild reactions are only expected within 3m and a strong reaction within just 1m of the vessel. These factors mean that any disturbance will be extremely limited.	Sole are distributed throughout the area and the Thames Estuary is an important spawning ground. Sole may therefore be present within the zones of behavioural response to dredging noise (up to 130m from a dredger). Potentially sensitive sole nursery areas are located near the coast, outside the zone of behavioural response. This, together with the low hearing ability of the species means that any disturbance will be extremely limited.	Cod are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which cod may be displaced represents a very small proportion of the total habitat available.	Whiting are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which whiting may be displaced represents a very small proportion of the total habitat available.	Herring are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. All 3 behavioural impact contours from this licence area overlap with the important herring nursery area in the region therefore juvenile herring may potentially be impacted.	Sprat are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance, mild and strong behavioural response contours. Sprat spawning and nursery areas extend across much of the southern North Sea and sprat do not have the same specific habitat requirements as other species. The area of available habitat within which mild or strong behavioural reactions from dredging in this area could potentially occur constitutes a very small proportion of available habitat.	Sea lampreys are capable of moving over large areas throughout the Outer Thames and therefore their distribution may overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. There is a low likelihood of river lamprey presence within the area of predicted behavioural response, due to their predominantly coastal presence during migration.
Consider at EIA?	Yes	No	No	No	No	No	Yes	No	No

Dredging Area	Harbour Porpoise	Harbour / Grey Seal	Thornback ray	Sole	Cod	Whiting	Herring	Sprat	Lampreys
447	Harbour porpoise may be located in this area and may be disturbed within 5 km of dredging vessels. Mild behavioural reactions are expected within 2 km; strong reactions within 500m. There is therefore potential for harbour porpoise to be displaced as a result of dredging in this licence area.	Some populated areas fall within the boundary of a low likelihood of disturbance from this licence area (7km) but none are within the predicted area of mild or strong behavioural reactions. No significant disturbance to foraging seals is therefore anticipated.	Thornback ray spawn throughout the outer Thames and their distribution overlaps with the areas of behavioural response which may occur up to 130m from a dredging vessel. However the licence area is a long distance from the main spawning area and mild reactions are only expected within 3m and a strong reaction within just 1m of the vessel. These factors mean that any disturbance will be extremely limited.	Sole are distributed throughout the area and the Thames Estuary is an important spawning ground. Sole may therefore be present within the zones of behavioural response to dredging noise (up to 130m from a dredger). Potentially sensitive sole nursery areas are located near the coast, outside the zone of behavioural response. This, together with the low hearing ability of the species means that any disturbance will be extremely limited.	Cod are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which cod may be displaced represents a very small proportion of the total habitat available.	Whiting are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which whiting may be displaced represents a very small proportion of the total habitat available.	Herring are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. All 3 behavioural impact contours from this licence area overlap with the important herring nursery area in the region therefore juvenile herring may potentially be impacted.	Sprat are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance, mild and strong behavioural response contours. Sprat spawning and nursery areas extend across much of the southern North Sea and sprat do not have the same specific habitat requirements as other species. The area of available habitat within which mild or strong behavioural reactions from dredging in this area could potentially occur constitutes a very small proportion of available habitat.	Sea lampreys are capable of moving over large areas throughout the Outer Thames and therefore their distribution may overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. There is a low likelihood of river lamprey presence within the area of predicted behavioural response, due to their predominantly coastal presence during migration.
Consider at EIA?	Yes	No	No	No	No	No	Yes	No	No
108 / 1	Harbour porpoise may be located in this area and may be disturbed within 5 km of dredging vessels. Mild behavioural reactions are expected within 2 km; strong reactions within 500m. There is therefore potential for harbour porpoise to be displaced as a result of dredging in this licence area.	The distribution of seals does not overlap with the zones of behavioural response. No behavioural responses to dredging in this licence area are expected.	Thornback ray spawn throughout the outer Thames and their distribution overlaps with the areas of behavioural response which may occur up to 130m from a dredging vessel. However the licence area is a long distance from the main spawning area and mild reactions are only expected within 3m and a strong reaction within just 1m of the vessel. These factors mean that any disturbance will be extremely limited.	Sole are distributed throughout the area and the Thames Estuary is an important spawning ground. Sole may therefore be present within the zones of behavioural response to dredging noise (up to 130m from a dredger). Potentially sensitive sole nursery areas are located near the coast, outside the zone of behavioural response. This, together with the low hearing ability of the species means that any disturbance will be extremely limited.	Cod are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which cod may be displaced represents a very small proportion of the total habitat available.	Whiting are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which whiting may be displaced represents a very small proportion of the total habitat available.	Herring are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. All 3 behavioural impact contours from this licence area overlap with the important herring nursery area in the region therefore juvenile herring may potentially be impacted.	Sprat are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance, mild and strong behavioural response contours. Sprat spawning and nursery areas extend across much of the southern North Sea and sprat do not have the same specific habitat requirements as other species. The area of available habitat within which mild or strong behavioural reactions from dredging in this area could potentially occur constitutes a very small proportion of available habitat.	Sea lampreys are capable of moving over large areas throughout the Outer Thames and therefore their distribution may overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. There is a low likelihood of river lamprey presence within the area of predicted behavioural response, due to their predominantly coastal presence during migration.
Consider at EIA?	Yes	No	No	No	No	No	Yes	No	No
257	Harbour porpoise may be located in this area and may be disturbed within 5 km of dredging vessels. Mild behavioural reactions are expected within 2 km; strong reactions within 500m. There is therefore potential for harbour porpoise to be displaced as a result of dredging in this licence area.	Some populated areas fall within the boundary of a low likelihood of disturbance from this licence area (7km) but none are within the predicted area of mild or strong behavioural reactions. No significant disturbance to foraging seals is therefore anticipated.	Thornback ray spawn throughout the outer Thames and their distribution overlaps with the areas of behavioural response which may occur up to 130m from a dredging vessel. However the licence area is a long distance from the main spawning area and mild reactions are only expected within 3m and a strong reaction within just 1m of the vessel. These factors mean that any disturbance will be extremely limited.	Sole are distributed throughout the area and the Thames Estuary is an important spawning ground. Sole may therefore be present within the zones of behavioural response to dredging noise (up to 130m from a dredger). Potentially sensitive sole nursery areas are located near the coast, outside the zone of behavioural response. This, together with the low hearing ability of the species means that any disturbance will be extremely limited.	Cod are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which cod may be displaced represents a very small proportion of the total habitat available.	Whiting are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which whiting may be displaced represents a very small proportion of the total habitat available.	Herring are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. All 3 behavioural impact contours from this licence area overlap with the important herring nursery area in the region therefore juvenile herring may potentially be impacted.	Sprat are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance, mild and strong behavioural response contours. Sprat spawning and nursery areas extend across much of the southern North Sea and sprat do not have the same specific habitat requirements as other species. The area of available habitat within which mild or strong behavioural reactions from dredging in this area could potentially occur constitutes a very small proportion of available habitat.	Sea lampreys are capable of moving over large areas throughout the Outer Thames and therefore their distribution may overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. There is a low likelihood of river lamprey presence within the area of predicted behavioural response, due to their predominantly coastal presence during migration.
Consider at EIA?	Yes	No	No	No	No	No	Yes	No	No

Dredging Area	Harbour Porpoise	Harbour / Grey Seal	Thornback ray	Sole	Cod	Whiting	Herring	Sprat	Lampreys
108 / 3, 109 / 1, 113 / 1	Harbour porpoise may be located in this area and may be disturbed within 5 km of dredging vessels. Mild behavioural reactions are expected within 2 km; strong reactions within 500m. There is therefore potential for harbour porpoise to be displaced as a result of dredging in this licence area.	The distribution of seals does not overlap with the zones of behavioural response. No behavioural responses to dredging in this licence area are expected.	Thornback ray spawn throughout the outer Thames and their distribution overlaps with the areas of behavioural response which may occur up to 130m from a dredging vessel. However the licence area is a long distance from the main spawning area and mild reactions are only expected within 3m and a strong reaction within just 1m of the vessel. These factors mean that any disturbance will be extremely limited.	Sole are distributed throughout the area and the Thames Estuary is an important spawning ground. Sole may therefore be present within the zones of behavioural response to dredging noise (up to 130m from a dredger). Potentially sensitive sole nursery areas are located near the coast, outside the zone of behavioural response. This, together with the low hearing ability of the species means that any disturbance will be extremely limited.	Cod are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is overlap of all these contours with the cod nursery area, therefore there is a potential for juvenile cod to be impacted.	Whiting are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which whiting may be displaced represents a very small proportion of the total habitat available.	Herring are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. All 3 behavioural impact contours from this licence area overlap with the important herring nursery area in the region therefore juvenile herring may potentially be impacted.	Sprat are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance, mild and strong behavioural response contours. Sprat spawning and nursery areas extend across much of the southern North Sea and sprat do not have the same specific habitat requirements as other species. The area of available habitat within which mild or strong behavioural reactions from dredging in this area could potentially occur constitutes a very small proportion of available habitat.	Sea lampreys are capable of moving over large areas throughout the Outer Thames and therefore their distribution may overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours, however behavioural . There is a low likelihood of river lamprey presence within the area of predicted behavioural response, due to their predominantly coastal presence during migration.
Consider at EIA?	Yes	No	No	No	Yes	No	Yes	No	No
327	Harbour porpoise may be located in this area and may be disturbed within 5 km of dredging vessels. Mild behavioural reactions are expected within 2 km; strong reactions within 500m. There is therefore potential for harbour porpoise to be displaced as a result of dredging in this licence area.	The distribution of seals does not overlap with the zones of behavioural response. No behavioural responses to dredging in this licence area are expected.	Thornback ray spawn throughout the outer Thames and their distribution overlaps with the areas of behavioural response which may occur up to 130m from a dredging vessel. However the licence area is a long distance from the main spawning area and mild reactions are only expected within 3m and a strong reaction within just 1m of the vessel. These factors mean that any disturbance will be extremely limited.	Sole are distributed throughout the area and the Thames Estuary is an important spawning ground. Sole may therefore be present within the zones of behavioural response to dredging noise (up to 130m from a dredger). Potentially sensitive sole nursery areas are located near the coast, outside the zone of behavioural response. This, together with the low hearing ability of the species means that any disturbance will be extremely limited.	Cod are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is overlap of all these contours with the cod nursery area, therefore there is a potential for juvenile cod to be impacted.	Whiting are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is overlap of all these contours with the main whiting spawning area in the southern North Sea, therefore there is a potential for whiting reproduction to be impacted.	Herring are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. All 3 behavioural impact contours from this licence area overlap with the important herring nursery area in the region therefore juvenile herring may potentially be impacted.	Sprat are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance, mild and strong behavioural response contours. Sprat spawning and nursery areas extend across much of the southern North Sea and sprat do not have the same specific habitat requirements as other species. The area of available habitat within which mild or strong behavioural reactions from dredging in this area could potentially occur constitutes a very small proportion of available habitat.	Sea lampreys are capable of moving over large areas throughout the Outer Thames and therefore their distribution may overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. There is a low likelihood of river lamprey presence within the area of predicted behavioural response, due to their predominantly coastal presence during migration.
Consider at EIA?	Yes	No	No	No	Yes	Yes	Yes	No	No
119 / 3	Harbour porpoise may be located in this area and may be disturbed within 5 km of dredging vessels. Mild behavioural reactions are expected within 2 km; strong reactions within 500m. There is therefore potential for harbour porpoise to be displaced as a result of dredging in this licence area.	The distribution of seals does not overlap with the zones of behavioural response. No behavioural responses to dredging in this licence area are expected.	Thornback ray spawn throughout the outer Thames and their distribution overlaps with the areas of behavioural response which may occur up to 130m from a dredging vessel. However the licence area is a long distance from the main spawning area and mild reactions are only expected within 3m and a strong reaction within just 1m of the vessel. These factors mean that any disturbance will be extremely limited.	Sole are distributed throughout the area and the Thames Estuary is an important spawning ground. Sole may therefore be present within the zones of behavioural response to dredging noise (up to 130m from a dredger). Potentially sensitive sole nursery areas are located near the coast, outside the zone of behavioural response. This, together with the low hearing ability of the species means that any disturbance will be extremely limited.	Cod are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is overlap of all these contours with the cod nursery area, therefore there is a potential for juvenile cod to be impacted.	Whiting are distributed throughout the area therefore they are likely to be present within the 1.1km contour of low likelihood of disturbance. A strong and mild reaction is expected within 4m and 30m of the dredging vessel respectively. There is overlap of all these contours with the main whiting spawning area in the southern North Sea, therefore there is a potential for whiting reproduction to be impacted.	Herring are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. However, there is no overlap of the behavioural response contours with particularly sensitive spawning and nursery areas for this species and the area of feeding habitat from which herring may be displaced represents a very small proportion of the total habitat available.	Sprat are distributed throughout the area therefore their distribution is likely to overlap with the low likelihood of disturbance, mild and strong behavioural response contours. Sprat spawning and nursery areas extend across much of the southern North Sea and sprat do not have the same specific habitat requirements as other species. The area of available habitat within which mild or strong behavioural reactions from dredging in this area could potentially occur constitutes a very small proportion of available habitat.	Sea lampreys are capable of moving over large areas throughout the Outer Thames and therefore their distribution may overlap with the low likelihood of disturbance (1.9km), mild (60m) and strong (6m) behavioural response contours. There is a low likelihood of river lamprey presence within the area of predicted behavioural response, due to their predominantly coastal presence during migration.
Consider at EIA?	Yes	No	No	No	Yes	Yes	No	No	No

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ERM's Oxford Office

Eaton House
Wallbrook Court
North Hinskey Lane
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