KEEPING BRITAIN TRADING

IMMINGHAM EASTERN RO-RO TERMINAL

Environmental Statement: Volume 1
Chapter 9: Nature Conservation and Marine Ecology
Document Reference: 8.2.9

APFP Regulations 2009 – Regulation 5(2)(a) and 5(2)(e)
PINS Reference – TR030007

February 2023

Page intentionally left blank

Immingham Eastern Ro-Ro Terminal

Environmental Statement: Volume 1
Chapter 9: Nature Conservation and Marine Ecology

February 2023

Document Information

Document Information	
Project	Immingham Eastern Ro-Ro Terminal
Document title	Environmental Statement: Volume 1 Chapter 9: Nature Conservation and Marine Ecology
Commissioned by	Associated British Ports
Document ref	8.2.9
APFP Reg 2009	Regulation 5(2)(a) and 5(2)(e)
Prepared by	ABPmer

Date	Version	Revision Details
10/02/2023	1	

Contents

Tables

9 Nature Conservation and Marine Ecology

9.1 Introduction

9.1.1 This chapter provides an assessment of any potentially significant effects of the proposed Immingham Eastern Ro-Ro Terminal (IERRT) project on nature conservation and marine ecology and describes the measures proposed to mitigate the identified significant effects. The principal marine elements of the proposed development are shown on Figure 1.2 in Volume 2 of this Environmental Statement (ES) (Application Document Reference number 8.3). This chapter has been prepared by ABPmer.

9.1.2 The following receptors have been considered as part of the assessment:

- Nature conservation designations and protected species;
- Benthic habitats and species;
- Fish;
- Marine mammals; and
- Coastal waterbirds.

9.1.3 With respect to the section of the chapter that deals with coastal waterbirds, specific consideration is given to potential effects on species within marine habitats (i.e., intertidal and adjacent areas of open water). Terrestrial habitats within the proposed development area are not considered to support functionally linked feeding or roosting habitats for wintering/passage coastal waterbirds, as is explained in Section 8.4.5.3.1 of Annex C of the Preliminary Ecological Appraisal (PEA) - provided as Appendix 6.2 in Volume 3 of the ES (Application Document Reference number 8.4). As noted in the PEA, however, the site has the potential to support breeding Little Ringed Plover. Proposed mitigation for this species is discussed in Section 6.2 (Final ES scope) of Chapter 6 of this ES (Impact Assessment Approach).

9.1.4 There are no classified commercial shellfish (bivalve) beds in the Humber Estuary (Cefas, 2021) and the areas around the proposed IERRT and disposal sites do not support other commercial shellfisheries (such as crab/lobsters using creels or the collection of whelks). On this basis, commercial shellfisheries have been scoped out of the assessment. Relevant fauna which are considered shellfish species (such as cockles or clams), however, are considered within the benthic habitats and species assessment.

9.1.5 A number of figures included in Volume 2 of this ES assist in describing the existing environment (baseline) as follows:

- Figure 9.1 shows the location of the Immingham Outer Harbour coastal waterbird surveys;
- The location of the project specific intertidal and subtidal benthic sampling stations is shown in Figure 9.2;
- Internationally and nationally designated conservation sites are shown in Figure 9.3;
- Figure 9.4 and Figure 9.5 show the location of spawning/nursery grounds of commercial fish species and transitional and coastal waters (TrAC) fish monitoring stations in the vicinity of the proposed development respectively;
- Annual grey seal pup counts and aerial counts of grey seals at Donna Nook are provided in Figure 9.6 and Figure 9.7 respectively with harbour porpoise sightings in the Humber Estuary since 2000 shown in Figure 9.8;
- The 5-year mean peak number of birds in IOH count Sector B (which overlaps with proposed development) during different months is provided in Figure 9.9 of this ES;
- The distribution of coastal waterbirds within Sector B is shown in Figure 9.10; and
- The potential disturbance buffer that has been applied to the assessment is shown in Figures 9.11 to Figure 9.13.

9.1.6 The Physical Processes assessment (Chapter 7), Water and Sediment Quality assessment (Chapter 8) and underwater noise assessment (Appendix 9.2 of the ES) have informed the outcomes of the nature conservation and marine ecology assessment.

9.1.7 Relevant aspects of the nature conservation and marine ecology assessment presented in this chapter inform the Habitat Regulations Assessment (HRA) (Application Document Reference number 9.6) and Water Framework Directive (WFD) Compliance Assessment (Appendix 8.1 of this ES).

9.2 Definition of the study area

9.2.1 The study area for this assessment is the area over which potential direct and indirect effects of the IERRT project are predicted to occur during the construction and operational periods. The direct effects on nature conservation and marine ecology receptors are those that occur within the footprint of the proposed development, such as the direct disturbance to benthic habitats and associated species as a result of construction. Indirect effects are those that may arise outside this footprint, such as the potential noise and visual disturbance effects on waterbirds during construction.

9.2.2 The study area for the nature conservation and marine ecology topic is focused on the Port of Immingham and proposed disposal sites with data for the wider Humber Estuary region presented where relevant to provide contextual information and to ensure the area of potential effects (e.g., noise disturbance) are fully considered.

9.3 Assessment methodology

Data and information sources

9.3.1 Marine ecological data for the Humber Estuary has been collected and analysed by ABPmer for over 20 years. This has been used to provide a robust baseline description of the area as well as providing an early understanding of potential impacts.

9.3.2 Current baseline conditions have been determined by a desk-based review of available information. A project-specific benthic survey has also been undertaken to characterise seabed habits and species in the proposed dredge and disposal footprints.

9.3.3 The main desk-based sources of information that have been reviewed to inform the current baseline description within the vicinity of the proposed development include:

Nature conservation sites

- Natura 2000 standard data forms or information sheets for each designation: Information on the species and habitats listed in the original citations (JNCC, 2022a; JNCC, 2022b; JNCC, 2022c; JNCC, 2022d);
- Multi-Agency Geographic Information for the Countryside (MAGIC) Interactive Map (http://www.magic.gov.uk): Information on the boundaries of designated sites (Natural England, 2020); and
- Natural England Conservation Advice for Marine Protected Areas: Humber Estuary Special Area of Conservation (SAC) (Natural England, 2021a) and Humber Estuary Special Protection Area (SPA) (Natural England, 2021b) available at [redacted]

Benthic habitats and species

- Able Marine Energy Park Benthic Surveys: The results of intertidal benthic surveys (undertaken in 2015 and 2016) using a 0.01 m² core sample and a subtidal survey in 2016 using a 0.1 m² Day Grab in the North Killingholme area (Able UK Limited, 2021);
- Humber Estuary SAC Intertidal Sediment Survey: Ecological survey work undertaken in 2014 to monitor and assess the intertidal mudflat and sandflat communities of the Humber Estuary (Franco *et al.,* 2015);
- Immingham Outer Harbour (IOH) Benthic Surveys: Intertidal sampling at 14 stations (using a Day Grab (0.06 m²) or Van Veen Grab (0.03 m²)) and subtidal sampling at 17 stations in the Port of Immingham area in 2009 (ABPmer, 2009);
- South Humber Channel Marine Studies: Benthic sampling in the intertidal (using a 0.01 m² core from 36 stations) and subtidal (0.1 m² Hamon grab from 30 stations) between the Humber Sea Terminal and Immingham Port undertaken in 2010 (Institute of Estuarine and Coastal Studies (IECS), 2010);

- HU056 Disposal Site Monitoring: Benthic invertebrate samples collected at five sites within the disposal sites and at six locations nearby (triplicate samples at all locations) in 2017 (ABPmer, 2017); and
- Clay Huts Disposal Site Benthic Monitoring: Benthic invertebrate samples collected from four stations in 2008 from within and near to the Clay Huts disposal sites (ABPmer, 2009).

Fish

- South Humber Channel Marine Studies: Fish surveys in the intertidal (four double-ended fyke nets) and subtidal (eight beam trawls) between the Humber Sea Terminal and Port of Immingham undertaken in 2010 (IECS, 2010). These sites are located approximately 3 to 4 km from the proposed development;
- Review of fish population data in the Humber Estuary: A review of available data to describe the fish populations in the Humber Estuary (Environment Agency, 2013);
- The Humber Regional Environmental Characterisation (REC): Fish ecology information provided in the Marine Aggregate Levy Sustainability Fund (MALSF (2011);
- Environment Agency TraC Fish Monitoring: The results of the most recently available WFD fish monitoring for the nearest sites to the proposed development (seine netting/bream trawls at Foulholme Sands and otter trawls at Burcom). The Foulholme Sands surveys were undertaken twice a year in the spring and autumn with the Burcom surveys annually in the early winter. These sites are located approximately 4 km from the proposed development with data available up to 2017 for Foulholme Sands and 2019 for Burcom (Environment Agency, 2021);
- Cefas Spawning and Nursery Grounds of Selected Fish Species in UK waters: Distribution maps of the main spawning and nursery grounds for 14 commercially important species (cod, haddock, whiting, saithe, Norway pout, blue whiting, mackerel, herring, sprat, sandeels, plaice, lemon sole, sole and Norway lobster) (Ellis *et al*., 2012); and
- Fish Atlas of the Celtic Sea, North Sea, and Baltic Sea: The study provides an overview of information collected from internationally coordinated and national surveys and presents data and information on the recent distribution and biology of demersal and small pelagic fish in these ecoregions (Heessen *et al.,* 2015).

Marine mammals

- Donna Nook Seal Counts: The latest pup counts available from the Lincolnshire Wildlife Trust for winter 2021/22 and 2020/21;
- Sea Watch Foundation Review of Marine Mammals in the Humber Estuary Region: Information on cetacean status and distribution in the area derived from survey data and the national sightings database maintained by the Sea Watch Foundation with sightings data from 2000 onwards analysed (Evans and Bertulli, 2021);
- Records of marine mammal sightings from the Lincolnshire Environmental Records Centre (LERC, 2021) and National Biodiversity Network (NBN, 2021);

- Distribution maps of cetacean and seabird populations in the North-East Atlantic: Distribution maps of cetaceans and seabirds based on survey data in the North-East Atlantic between 1980 and 2018 collated and standardised (Waggitt *et al*., 2020);
- At-sea Distribution Data for Grey and Harbour Seals: The latest habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles (including the Humber Estuary region) estimated using data from animal-borne telemetry tags by the Sea Mammal Research Unit (SMRU) (Carter *et al*., 2020);
- Donna Nook Telemetry Data; The results of the tagging of 11 grey seals from the Donna Nook colony to understand the movements of grey seals in the region (Russel, 2016);
- Special Committee on Seals (SCOS) Annual Report: Information on the status of seals around the UK coast is reported annually by the SMRU advised SCOS (SCOS, 2022);
- The Identification of Discrete and Persistent Areas of Relatively High Harbour Porpoise Density in the Wider UK Marine Area: The report presents the results of 18 years of survey data in the Joint Cetacean Protocol (JCP), undertaken to inform the identification of discrete and persistent areas of relatively high harbour porpoise density in the UK marine area (Heinänen and Skov, 2015); and
- Small Cetaceans in European Atlantic Waters and the North Sea (SCANS) III Data: Cetacean surveys to estimate the abundance of cetacean species in shelf and oceanic waters of the European Atlantic undertaken in 2016. Teams of observers searched along 60,000 km of transect line, recording thousands of groups of cetaceans from 19 different species. The survey (SCANS-III) is the third in a series that began in 1994 (SCANS) and continued in 2005 (SCANS-II) (Hammond *et al*., 2021).

Coastal waterbirds

- IOH Ornithology Surveys: Pre and post consent monitoring of coastal waterbirds as part of the IOH development. These surveys which overlap with the proposed development area (Figure 9.1) have been undertaken between October and March twice a month[1]. The surveys started in winter 1997/98 and have been ongoing annually since then. During each survey, either five counts (October and March) or four counts (November to February) are undertaken every two hours after high water. The most recent 5-years of data (2017/18 to 2021/22) has been analysed. In addition, the 2021/22 survey season started in August rather than October. The surveys have been continued on a monthly basis in 2022 rather than stopping in March as per previous years. On this basis, the results from surveys covering passage and summer months (August and September 2021 and April to September 2022) have also been presented;
- Wetland Bird Survey (WeBS) Core Counts Data: Core count data for data for 'Immingham Docks - Sector K' (ID 38905) which overlaps with the proposed development. These surveys are typically undertaken around high water. The most recent 5-years of data available from the British Trust

[1] Passage surveys have been undertaken on a weekly basis in March and April 2022 and will also be undertaken on a weekly basis from September to November 2022.

for Ornithology (BTO) (2016/17 to 2020/21) has been analysed. In addition, estuary wide WeBS data for the Humber Estuary for 2015/16 to 2019/20 has also been reviewed to provide contextual information (Frost *et al*., 2021) [2];
- Natural England Designated Sites Portal: Background information on the ecology of SPA qualifying bird species in the Humber Estuary (Natural England, 2021b);
- Population Trends for Species in the Humber Estuary: Information on long-term trends in the population status of waterbirds in the Humber Estuary is available for the period up to 2016/2017 from the latest WeBS 'Alerts Report' (Woodward *et al*., 2019a). This is an information source describing waterbird numbers on protected areas and has an 'alert system' where species that have undergone major declines in numbers are identified; and
- BTO Research Report Analysing WeBS data for the Humber Estuary: Population trends of waterbird species in different parts of the Humber Estuary for the period 2000/01 to 2016/17 (Woodward *et al.,* 2018).

9.3.4 Site specific surveys that have been undertaken to underpin the assessments include:

- **Intertidal benthic sampling:** Ten intertidal stations were sampled in September 2021 using a 0.01 m² hand-held core. The location of the survey stations are shown in Figure 9.2.
- **Subtidal benthic sampling:** Ten subtidal stations were sampled in September 2021 (using a 0.1 m² Day Grab) within and near to the proposed development footprint. In addition, six stations were sampled at each of the disposal sites (HU060 and HU056) using a 0.1 m² Day Grab (four within each of the disposal sites and two nearby to each of the disposal sites). The location of the survey stations is shown in Figure 9.2.

9.3.5 All the samples collected were analysed for macrofaunal analysis (faunal composition, abundance and biomass), Particle Size Analysis (PSA) and Total Organic Carbon (TOC). Polychaetes, bivalves and other species considered waterbird prey items were also measured and categorised using size classes. The methods and results of these surveys are included in Appendix 9.1 and summarised in Section 9.6 of this chapter.

Determining the significance of effects

9.3.6 To facilitate the impact assessment process and ensure consistency in the terminology of significance, a standard assessment methodology has been applied to determine the significance of effects. This methodology has been developed from a range of sources, including relevant Environmental Impact Assessment (EIA) Regulations, the EIA Directive (2014/52/EU), statutory and non-statutory guidance, consultations and ABPmer's previous

[2] It should be noted that as a result of COVID-19 lockdowns, the BTO were unable to undertake comprehensive counts and therefore produce robust data for 2020/21 at an estuary-wide scale and therefore the period 2015/16 to 2019/20 is the most recent 5 years of data available from the BTO.

(extensive) EIA project experience. The assessment also follows the principles of relevant guidance, including Institute of Environmental Management and Assessment (IEMA) guidelines, and the latest Chartered Institute of Ecology and Environmental Management (CIEEM) guidelines for ecological impact assessment in the UK and Ireland (which combine advice for terrestrial, freshwater and coastal environments) (CIEEM, 2018). The methodology adopted is considered to be 'best practice'.

9.3.7 Similarly, the marine ecology impact assessment follows a well-established approach that has been developed specifically for this topic and has been applied in numerous marine EIAs and accepted by relevant stakeholders. It is considered, therefore, the most appropriate methodology to use in the marine ecology assessment of the proposed development.

9.3.8 The environmental issues are divided into distinct 'receiving environments' or 'receptors'. The effect of the proposed development on each of these has been assessed by describing in turn:

- The baseline environmental conditions of each receiving environment;
- The 'impact pathways' by which the receptors could be affected;
- The significance of the effect occurring as a result of the impact; and
- The measures to mitigate for significant adverse effects where these are predicted.

9.3.9 In accordance with CIEEM (2018), an impact is defined as an action resulting in changes to an ecological feature (e.g., construction activities resulting in the direct loss of benthic habitat) and an effect is the outcome to an ecological feature from an impact (e.g., the effects on fish from the loss of benthic habitat).

Magnitude of impacts

9.3.10 The first stage in the assessment process involves understanding the impact magnitude which is determined by predicting the scale of any potential change in baseline conditions.

9.3.11 Magnitude of change needs to be considered in spatial and temporal terms (including duration, frequency and seasonality), and against background environmental conditions in a study area. The assessment of magnitude should also be carried out taking account of any inherent design mitigation that forms part of the development description.

9.3.12 The following criteria has been used to assess the magnitude of impact:

- Negligible: Changes that are barely discernible from existing baseline conditions;
- Small: Relatively localised changes that are often temporary in nature and / or a receptor has limited exposure to change;
- Medium: Receptors are subject to changes that occur over a large spatial area, but the effects are considered temporary; and

- High: Receptors are subject to changes over a large spatial area with effects that are considered permanent / long-term duration.

9.3.13 Once a magnitude has been assessed, this is then considered in terms of the probability of occurrence (i.e., likelihood that the impact will occur) to derive an overall level of exposure.

Sensitivity of receptors

9.3.14 Sensitivity can be described as the intolerance of a habitat, community or individual of a species to an environmental change and essentially considers the response characteristic of the feature. The sensitivity of a marine habitat or species is considered to be a product of the following (Tyler-Walters *et al.*, 2018):

- The likelihood of damage (termed intolerance or resistance) due to a pressure. This could include behavioural effects, physiological damage or even mortality of individuals or populations; and
- The rate of (or time taken for) recovery (termed recoverability, or resilience) of marine species once the pressure has abated or been removed.

9.3.15 The following criteria have been used to assess sensitivity:

- Low: Pressures in which the likelihood of damage to individuals or populations is low with recoverability expected to occur over short timescales;
- Moderate: Pressures in which damage to individuals or populations could occur but recoverability is expected to occur over short to moderate timescales; and
- High: Pressures in which damage to individuals or populations is highly likely with either no recoverability or recoverability expected to occur over longer timescales.

9.3.16 Table 9.1 summarises the sensitivity level that has been assigned to different receptors considered in this assessment based on consideration of the criteria highlighted above. Further rationale for the sensitivity levels that have been assigned are included for each pathway in the impact assessment.

Table 9.1. Assessed sensitivity of marine ecology receptors.

Receptor	Sensitivity
Benthic habitats and species	The benthic habitats and species in the dredge footprint and disposal sites are considered to have a **high** sensitivity to habitat loss, a **low** sensitivity to habitat change (due to relatively high recoverability), a **low** to **moderate** sensitivity to non-native species introductions and a **low** sensitivity to water quality and underwater noise on the scale predicted.

Receptor	Sensitivity
Fish	Fish species in the study area are considered to have a **low** sensitivity to marine habitat change on the scale predicted for the project (due to the high mobility of the species). They are considered to have a **low to moderate sensitivity** to water quality and underwater noise (depending on the species and activity).
Marine mammals	Marine mammals are generally considered to have a **low** sensitivity to changes in water quality and marine habitat change / loss on the scale predicted for the project (due to the high mobility of the species). The species in the study area are considered to have a **moderate** sensitivity to the anticipated level of underwater noise generated by the IERRT project from piling and a low sensitivity to noise due to dredging activities.
Coastal waterbirds	Coastal waterbirds are generally considered to have a **low** sensitivity to marine habitat change / loss on the scale predicted for the project (due to the high mobility of the species in the study area). The species in the study area are considered to have a **low to high** sensitivity to noise and visual disturbance (depending on the species) and **moderate** sensitivity to changes in feeding and roosting habitat as a result of the presence of marine infrastructure on the scale predicted.

Receptor importance

9.3.17 In considering the magnitude of impacts and sensitivity of the receptor, it is also necessary to identify whether an ecological feature is 'important'. As such, where possible, habitats, species and their populations have been valued on the basis of a combination of their conservation status, rarity and ecological/socioeconomic value using contextual information - where it exists.

9.3.18 The CIEEM (2018) guidelines recognise that determining ecological importance is a complex process, which is a matter of professional judgement guided by the importance and relevance of a number of factors. These include designation and legislative protection as well as biodiversity value and secondary / supporting value (e.g. where habitats may function as a buffer or resource associated with an adjacent designated area).

9.3.19 The importance of each ecological receptor has been determined, based on the following criteria:

- Low: The receptor is neither protected nor designated and is considered to be of low to moderate biodiversity or supporting value;
- Medium: Statutory protection / designation is afforded to a receptor but it is considered to be of low to moderate biodiversity / supporting value or the receptor does not receive statutory protection but is considered to be of high biodiversity or supporting value; and

- High: Statutory protection / designation is afforded to a receptor and the receptor is considered to be of high biodiversity or supporting value.

9.3.20 The importance of a receptor has also been considered with regard to the marine geographic frame of reference defined below as recommended in the CIEEM (2018) guidelines:

- International and European;
- National;
- Regional (Humber Estuary); and
- Local (Port of Immingham area).

9.3.21 Table 9.2 summarises the importance level that has been assigned to the different receptors that have, to date, been assessed based on the criteria highlighted above.

Table 9.2. Assessment of the importance of marine ecology receptors

Receptor	Importance
Benthic habitats and species	**Low to high** (local to international) importance: Intertidal habitats in the study area are considered to be of **high** importance due to their designated status (as a qualifying feature of the Humber Estuary SAC and Sites of Special Scientific Interest (SSSI), NERC listed habitat and as supporting habitat of the Humber Estuary SPA, as well as the functional importance they provide in terms of benthic prey resources for intertidal birds. The disposal sites identified for the disposal of the dredged arisings are considered to be of **moderate** importance due to their typically impoverished nature and low ecological value albeit characteristic of the *Sandbanks which are slightly covered by sea water all the time* qualifying feature of the Humber Estuary SAC. The importance of other subtidal habitats in the vicinity of the proposed development is also considered to be **moderate.** This is because subtidal species in the area are considered to be commonly occurring and of low conservation concern with the habitats not characteristic of any of the qualifying features of overlapping designated sites although it is noted that subtidal habitats form a component of the 'Estuaries' feature of the SAC.
Fish	**Low to high** (local to international) importance: Some species are commonly occurring and not protected - these are considered to be of low importance. Other species which are commercially important species (e.g., whiting, Dover sole and plaice) are considered to be of **moderate** importance. Species such as diadromous migratory species (European eel, Atlantic salmon, sea trout, sea lamprey, river lamprey, twaite shad, allis shad, European smelt) are considered to be of **high** importance.
Marine mammals	**High** (international) importance: All species are of conservation interest and protected.
Coastal waterbirds	**High** (international) importance: All species are of conservation interest and protected.

Significance criteria

9.3.22 Determination of the significance of the predicted ecological effects is based on professional judgement having regard to the positive (beneficial) or negative (adverse) nature of a potential impact.

9.3.23 In summary, to assess the significance of effects, the magnitude of the impact pathway and the probability of it occurring is evaluated to understand the exposure to change. This is then assessed against the sensitivity of a receptor / feature to understand its vulnerability. Finally, this is considered in the context of the importance of a receptor / feature to generate a level of significance for effects resulting from each impact pathway.

9.3.24 The CIEEM (2018) guidelines state that an effect should be determined as being significant when it "*either supports or undermines biodiversity conservation objectives for important ecological* features". It relates to the weight that should be afforded to effects when decisions are made, and to the consequences, in terms of legislation, policy and / or development control. A significant adverse effect on a feature of importance (as defined in Table 9.3) would, therefore, be likely to generate the need for development control mechanisms, such as Development Consent Order (DCO) Protective Provisions or Requirements.

9.3.25 Whilst this assessment adopts an Ecological Impact Assessment (EcIA) approach and, therefore, expresses the significance of ecological effects with reference to a geographic frame of reference (as advocated in the CIEEM Guidelines), significance is also expressed using a generic EIA significance criteria. The generic criteria used throughout this report is based on an expression of severity, to describe the significance of environmental impacts. For ease of reference, Table 9.3 provides a means of relating the two approaches and is provided in order to allow the EcIA to be integrated into the wider EIA framework without compromising the CIEEM best practice approach.

9.3.26 To ensure transparency in the impact assessment, it is important to make clear the evidence-based or value-based judgments used at each stage of the assessment and how they have been attributed to a level of significance. This is presented in the impact assessment for each impact pathway.

9.3.27 Following the significance assessment, a confidence assessment was undertaken which recognises the degree of interpretation and professional judgement applied. This is presented in the summary table contained within the conclusions section of this chapter (Section 9.11). Confidence was assessed on a scale incorporating three values: low, medium and high.

9.3.28 As shown in Table 9.3, effects that are identified as being moderate or major adverse / beneficial are classified as significant effects and those as minor or negligible as not significant.

Table 9.3. Significance Criteria

Significance Level		Criteria	CIEEM Geographical Criteria
Significant	Major	These effects are likely to be important considerations at a local or district scale but, if adverse, are potential concerns to the project and may become key factors in the decision-making process.	Ecological impacts assessed as being significant at the regional scale and that have triggered a response in development control terms are considered to represent impacts that overall, within this assessment, are of major significance.
	Moderate	These effects, if adverse, while important at a local scale, are not likely to be key decision-making issues. Nevertheless, the cumulative effect of such issues may lead to an increase in the overall effects on a particular area or on a particular resource.	Ecological impacts assessed as being significant at the county/metropolitan scale, and that have triggered a response in development control terms, will be considered to represent impacts that overall, within this assessment, are of moderate significance.
Not significant	Minor	These effects may be raised as local issues but are unlikely to be of importance in the decision-making process. Nevertheless, they are of relevance in enhancing the subsequent design of the project and consideration of mitigation or compensation measures.	Ecological impacts assessed as being significant at the local scale, and that have triggered a response in development control terms, will be considered to represent impacts that overall, within this assessment, are of minor significance.
	Insignificant	No effect or an effect which is beneath the level of perception, within normal bounds of variation or within the margin of forecasting error.	Ecological impacts that have been assessed as not being significant at any geographic level.

Impact assessment guidance tables

9.3.29 The matrices in Table 9.4 to Table 9.6 have been used to help assess significance.

9.3.30 Table 9.4 has been used as a means of generating an estimate of exposure to change. Once a magnitude has been assessed, this has been combined with the probability of occurrence to arrive at an exposure score which can then be used for the next step of the assessment, which is detailed in Table 9.5. For example, an impact pathway with a medium magnitude of change and a high probability of occurrence would result in a medium exposure to change.

Table 9.4. Exposure to change, combining magnitude and probability of change

Probability of Occurrence	Magnitude of Change			
	Large	Medium	Small	Negligible
High	High	Medium	Low	Negligible
Medium	Medium	Medium/Low	Low /Negligible	Negligible
Low	Low	Low /Negligible	Negligible	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

9.3.31 Table 9.5 has then been used to score the vulnerability of the features/receptors of interest based on the sensitivity of those features and their exposure to a given change.

Table 9.5. Estimation of vulnerability based on sensitivity and exposure to change

Sensitivity of Feature (Table 9.1)	Exposure to change (Table 9.4)			
	High	Medium	Low	Negligible
High	High	High	Moderate	None
Moderate	High	Moderate	Low	None
Low	Moderate	Low	Low	None
None	None	None	None	None

9.3.32 The vulnerability has then been combined with the importance of the feature of interest using Table 9.6 to generate an initial level of significance. For example, if a high vulnerability is assessed against a feature of low importance, the level of significance of the effect is assessed as minor.

Table 9.6. Estimation of significance based on vulnerability and importance

Importance of Feature (Table 9.2)	Vulnerability of Feature to Impact (Table 9.5)			
	High	Moderate	Low	None
High	Major	Moderate	Minor	Insignificant
Moderate	Moderate	Moderate/Minor	Minor/Insignificant	Insignificant
Low	Minor	Minor/Insignificant	Insignificant	Insignificant
None	Insignificant	Insignificant	Insignificant	Insignificant

Significance criteria impact management (mitigation)

9.3.33 Impacts that are found to be significant in the process, (i.e., moderate and/or major adverse) may require mitigation measures to reduce residual impacts, as far as possible, to environmentally acceptable levels. Within the assessment procedure the use of mitigation measures will alter the risk of exposure and, hence, will require significance to be re-assessed and thus the residual impact (i.e., with mitigation) identified.

9.3.34 Mitigation measures considered throughout the EIA process can take three forms (IEMA, 2016):

- Primary (inherent) – modifications to the location or design of the development made during the pre-application phase that are an inherent (or embedded) part of the project. These are captured and taken into account in the initial impact assessment;
- Secondary (foreseeable) – actions that will require further activity in order to achieve the anticipated outcome (identified as necessary through the assessment process). Within the impact assessment process, the use of secondary mitigation measures will alter the risk of exposure and, hence, will require significance to be re-assessed and thus the residual impact (i.e. with mitigation) identified; and
- Tertiary (inexorable) – actions that would occur with or without input from an environmental impact assessment process, including actions that will be undertaken to meet other existing legislative requirements, or actions considered to be standard practices to manage commonly occurring environmental effects. These are captured and taken into account in the initial impact assessment.

9.3.35 In addition, it is appropriate to adopt a mitigation hierarchy which, from the CIEEM (2018) guidance on ecological impact assessment specifically, can be summarised as follows:

i. In the first instance, seek to adopt options that avoid harm;
ii. Identify ways to minimise adverse effects that cannot be completely avoided through mitigation;
iii. Provide compensation where there are significant residual adverse effects despite the mitigation proposed; and
iv. Provide net benefits (for biodiversity) above requirements for avoidance, mitigation or compensation.

9.3.36 In some instances, a decision may need to be taken despite residual uncertainty about the effects. In such cases, adaptive management, linked to a bespoke monitoring programme, is a well-established and recommended way of ensuring that any negative impacts or effects are addressed in the course of the development and during the subsequent operational phase.

9.4 Consultation

9.4.1 Consultation as to whether there are likely to be any nature conservation and marine ecology effects as a result of the construction and operation of the IERRT project has been undertaken with the Environment Agency, Natural England and the Marine Management Organisation (MMO). The outcomes of the formal scoping process, as well as any feedback received in response to the statutory consultation and publication of the Preliminary Environmental Information Report (PEIR) and supplementary statutory consultation and the publication of the Supplementary Consultation Report, have also been taken into account to inform the assessment.

9.4.2 The outcome of the consultation that has been undertaken, along with how it has influenced the nature conservation and marine ecology assessment, is presented in Table 9.7. Consultee responses have been grouped together where the same comment has been replicated several times within different sections of consultation documents.

Table 9.7. Summary of consultation

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
Planning Inspectorate (PINS) Marine Management Organisation (MMO) Natural England	Scoping Opinion, October 2021 Table ID 4.3.1 Appendix 2 MMO response Appendix 2 Natural England response	The Inspectorate agrees that changes to seabed habitats and species as a result of sediment deposition during piling which could affect all marine ecological receptors can be scoped out of further assessment.	Noted.
PINS	Scoping Opinion, October 2021 Table ID 4.3.2	The ES should include an assessment of indirect changes to seabed habitats and species as a result of changes to hydrodynamic and sedimentary processes caused by the presence of piled structures which could affect all marine ecological receptors or information demonstrating agreement with the relevant consultation bodies and the absence of a Likely Significant Effect (LSE).	This pathway has been scoped in to the assessment (Section 9.8 of this chapter).
PINS Natural England	Scoping Opinion, October 2021 Table ID 4.3.3	The ES should include an assessment of changes in water and sediment quality during piling which could affect all marine ecological receptors or information demonstrating agreement	This pathway has been scoped out of the assessment with a rationale for this provided in the ES (Section 9.8 of this chapter).

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
	Appendix 2 Natural England response	with the relevant consultation bodies and the absence of an LSE.	
PINS Natural England	Scoping Opinion, October 2021 Table ID 4.3.4 Appendix 2 Natural England response	The Inspectorate agrees that changes to marine mammal foraging habitat and prey resources during dredging and dredge disposal can be scoped out of further assessment.	Noted.
PINS	Scoping Opinion, October 2021 Table ID 4.3.5	The Inspectorate agrees that the additional traffic is unlikely to substantially increase collision risk to marine mammals during construction and operation.	Noted.
PINS	Scoping Opinion, October 2021 Table ID 4.3.6	The ES should include an assessment of water quality impacts during dredging/dredge disposal and operational berth vessel movements on marine mammals or information demonstrating agreement with the relevant consultation bodies and the absence of an LSE.	Water quality impacts on marine mammals have been scoped out of the assessment with a rationale for this provided in the ES (Section 9.8 of this chapter).
PINS	Scoping Opinion, October 2021 Table ID 4.3.7	If smelt are a feature of an MCZ likely to be affected by the Proposed Development then this should be assessed in the ES. It should be made clear in the assessment what	The Holderness Inshore Marine Conservation Zone (MCZ) is the nearest MCZ to the proposed development (located approximately 20 km away). This is considered to be beyond the zone of potential effects of the proposed

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		protections are given by law and policy for Features of Conservation Importance.	development. Consequently, reference to Feature of Conservation Importance (FOCI) has been removed from the baseline section for the ES.
PINS Natural England	Scoping Opinion, October 2021 Table ID 4.3.8 Appendix 2 Natural England response	The Applicant's attention is drawn to the comments from Natural England, where they highlight the potential for effects on North Killingholme Haven Pits Site of Special Scientific Interest (SSSI), The Lagoons SSSI and the Greater Wash Special Protection Area (SPA). The ES should clearly present and justify the zones of influence of the Proposed Development. Evidence should be presented of agreement wherever possible with relevant stakeholders, particularly Natural England.	It is noted that the North Killingholme Haven Pits SSSI which is located approximately 5 km away from the proposed development could be functionally linked to the mudflat habitat in the proposed development footprint with local populations of species such as Dunlin and Black-tailed Godwit potentially utilising both areas. However, Killingholme Haven Pits is considered too distant to be impacted directly by the Proposed development (such as through potential disturbance effects). Based on the predicted magnitude of potential effects and proposed mitigation, indirect impacts on the SSSI (e.g., changes in local population levels resulting from changes in distribution) would also be expected to be negligible. On this basis this designated site is not considered further in the assessment. Potential effects on the Greater Wash SPA (located approximately 20 km from the proposed development) is considered within the HRA (Application Document Reference number 9.6). In summary, it is considered highly unlikely that interest features of the Greater Wash SPA will overlap with any

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
			potential direct or indirect changes resulting from the construction and operational activities associated with the proposed development which are limited to within the vicinity of the Port of Immingham. On this basis this designated site is not considered further in the assessment. The Lagoons SSSI is located approximately 20 km from the proposed development with Little Tern a notified feature of the SSSI. However, data suggests that this species forages within 5 km of nesting sites (Woodward *et al.*, 2019b) with this species considered very rare within the Immingham area. On this basis, this notified feature will not overlap with any potential direct or indirect changes resulting from the construction and operational activities associated with the proposed development which are limited to within the vicinity of the Port of Immingham. This designated site is not, therefore, considered further in the assessment.
PINS Natural England	Scoping Opinion, October 2021 Table ID 4.3.9	Natural England has identified the potential for the new piers to lead to changes in foraging and roosting habitat which could affect the ecological function of the mudflats. The ES should either include an assessment of these effects or a	This pathway has been considered in the assessment (Section 9.8 of this chapter).

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
	Appendix 2 Natural England response	justification (supported by evidence) that no LSE would arise as a result of this effect pathway.	
PINS Natural England	Scoping Opinion, October 2021 Table ID 4.3.10 Appendix 2 Natural England response	Natural England has identified the potential for direct changes to benthic habitats and species beneath the pier structures to affect the ecological function of the mudflats. The ES should either include an assessment of these effects or a justification (supported by evidence) that no LSE would arise as a result of this effect pathway.	This pathway has been considered in the assessment (Section 9.8 of this chapter).
PINS MMO	Scoping Opinion, October 2021 Table ID 4.3.11 Appendix 2 MMO response	The ES should either include an assessment of effects of noise and vibration associated with the additional vessel movements in and out of the port (i.e., during operation) or a justification as to why significant effects are unlikely, supported by evidence of agreement to this approach from Natural England and the MMO.	Potential disturbance to coastal waterbirds resulting from noise and visual stimuli in operation (including vessel movements) has been considered in the assessment (Section 9.8 of this chapter). Operational underwater noise effects have been scoped out with a rationale provided in the ES (Section 9.8 of this chapter).
PINS MMO	Scoping Opinion, October 2021 Table ID 4.3.12	The MMO agree that a simple modelling approach in this instance is appropriate (though there are some limitations). The ES should provide full details of the underwater noise modelling used and a justification as to	Noted.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
	Appendix 2 MMO response	why the approach is considered to be robust.	
PINS MMO	Scoping Opinion, October 2021 Table ID 4.3.13 Appendix 2 MMO response	The MMO does not agree that the data sources identified in the Scoping Report are adequate to provide accurate abundance information on any shellfish species. To ensure the assessments in the ES are robust, the Inspectorate requires that they should either be based on a presence/absence approach or additional baseline data should be collected through desk studies or through field surveys. The Applicant is advised to agree the approach to collecting baseline data and undertaking the assessment of effects on shellfish with the MMO and other relevant stakeholders.	There are no classified commercial shellfish (bivalve) beds in the Humber Estuary (Cefas, 2021) and the areas around the proposed IERRT project and associated disposal sites do not support other commercial shellfisheries (such as crab/lobsters using creels or the collection of whelks). On this basis, commercial shellfisheries have been scoped out of the assessment. However, relevant fauna which are considered shellfish species (such as cockles or clams) are considered within the benthic habitats and species assessment.
PINS Natural England	Scoping Opinion, October 2021 Table ID 4.3.14 Appendix 2 Natural England response	The Applicant's attention is drawn to the comments from Natural England about the adequacy of existing ornithological datasets, particularly in relation to the need to cover the autumn passage period, low tide as well as high tide and information on the way birds are using the area. The ES must provide a robust assessment of the effects of the Proposed Development on bird populations,	The IOH surveys which overlap with the proposed Development cover low and high tide period. In addition, the 2021/22 survey season started in August rather than October (as per previous years). The surveys have been continued on a monthly basis in 2022 rather than stopping in March as per previous years. On this basis, the results from passage and summer months (August and September 2021 and April to

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		particularly those species associated with designated sites. Failure to include baseline data which fully covers the periods when significant numbers of birds are using the area affected by the Proposed Development may bring the adequacy of the ES into question.	September 2022) have also been presented. As a result it is considered that the baseline data is fully representative of birds that are using the area affected by the IERRT project.
Natural England	Scoping Opinion, October 2021 Appendix 2 Natural England response	We note that intertidal benthic invertebrate surveys are proposed. If birds are foraging in the development area, it would be beneficial to alter the methodology, so that they could also assess bird prey availability. This could be done through extending the core depths to 30 cm rather than 15 cm, to replicate probing depths of larger wading bird species and record the number and biomass of benthic prey species within size classes (this would determine the proportion that are a suitable prey size, i.e., not too small, for foraging birds). Ideally these surveys would take place in late summer, prior to the passage period, to provide an assessment of the prey availability prior to its depletion from foraging passage/wintering birds.	The intertidal survey was undertaken prior to receiving scoping responses in September 2021. Taking cores to 15 cm is the standard technique used in current sampling guidelines (such as for Environment Agency TrAC monitoring and in the Marine Monitoring Handbook) as well as previous surveys in the local area. The survey was therefore based on this standardised approach. Prey size class analysis has been undertaken.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
PINS	Scoping Opinion, October 2021 Table ID 4.3.15	The Inspectorate notes that the Applicant intends to undertake subtidal and intertidal benthic habitat surveys using the sampling methodology presented in the Scoping Report. The Applicant is advised to agree the methodology and the number of samples to be collected with Natural England and the MMO.	It was proposed that a sample plan would be submitted to Natural England to agree on the methods and number of samples in advance of the surveys. However, Natural England were not providing a Discretionary Advice Service during the period prior to sampling and as such this was not possible. However, the methods used were based on standardised methods for ecological surveys and is considered sufficient for the assessment.
Environment Agency	Scoping Opinion, October 2021 Appendix 2 Environment Agency response Consultation meeting, 29 November 2021	We are pleased to see that site specific sediment quality and benthic ecology surveys are planned; this will inform the quality of the habitat to be lost and inform the Biodiversity Net Gain (BNG) metric.	Section 9.8 of this chapter provides an assessment of habitat loss as a result of the proposed development. As an NSIP, this project is not at this time subject to the requirement to deliver 10% BNG under The Environment Act 2021, as the requirement is yet to come into practical effect. Furthermore, as per subsequent Natural England advice during statutory consultation (summarised below in this table), the Defra metric should not be used to assess impacts and calculate compensation for habitat damage or loss in designated sites or irreplaceable habitat.
Environment Agency	Scoping Opinion, October 2021	We note the capital dredge location overlaps with the intertidal habitat, which will result in a loss of intertidal habitat in this location - we would expect the loss to be compensated for.	Section 9.6 of this chapter provides further information on the specific habitat and species interest features of the Humber Estuary and Section 9.8 includes consideration of the

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
	Appendix 2 Environment Agency response Pre-application meeting, 29 November 2021		effects of the proposed development on these features. A HRA has been undertaken alongside the ES (Application Document Reference number 9.6). The loss of intertidal habitat as a result of the IERRT project is considered *de minimis* in extent (0.012 ha direct loss and 0.01 ha indirect loss) following a change to the scheme design in order to reduce the loss and consequently is not considered to result in an adverse effect on site integrity. On this basis, compensatory habitat is not required.
MMO	Scoping Opinion, October 2021 Appendix 2 MMO response	The MMO supports the intended approach of using the results of the relevant physical processes assessments to confirm whether it is appropriate to screen out these impact pathways.	Noted.
MMO	Scoping Opinion, October 2021 Appendix 2 MMO response	The MMO agree with the proposals regarding the collection of new, site-specific benthic ecology data.	Noted.
MMO	Scoping Opinion, October 2021	The MMO would expect the effects of changes to Suspended Sediment Concentrations (SSC) and sediment	These pathways have been considered in the assessment (Section 9.8 of this chapter).

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
	Appendix 2 MMO response	deposition on benthic ecology receptors to be assessed in the ES.	
MMO	Scoping Opinion, October 2021 Appendix 2 MMO response	The MMO recommend that a summary table should be included, including relevant developments' current stage, location and timing of the proposed works. This will help to identify potential overlaps between activities that could lead to cumulative impacts on fish receptors.	This information has been included in the cumulative and in-combination effects assessment (Chapter 20 of this ES).
MMO	Scoping Opinion, October 2021 Appendix 2 MMO response	The MMO note that site-specific surveys are not considered necessary given that the existing available data sources are appropriate to characterise fish receptors on the study area. The MMO agree with this approach, however, would expect that the limitations of data sources used (e.g., gear selectivity and the timing of surveys) to be acknowledged.	This is described in Section 9.6 of this chapter.
Natural England	Scoping Opinion, October 2021 Appendix 2 Natural England response	Under Regulation 63 of the Conservation of Habitats and Species Regulations 2017 (as amended) an appropriate assessment (AA) needs to be undertaken. Should a Likely Significant Effect on a European/Internationally designated site be identified or be uncertain, the competent authority may need to prepare an AA, in addition to	A HRA has been undertaken alongside the ES (Application Document Reference number 9.6).

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		consideration of impacts through the EIA process.	
Natural England	Scoping Opinion, October 2021 Appendix 2 Natural England response	The Environmental Statement (ES) should include a full assessment of the direct and indirect effects of the development on the designated sites' features of special interest and should identify such mitigation measures as may be required in order to avoid, minimise or reduce any adverse significant effects.	Potential effects on designated sites are considered in the assessment in Section 9.8 of this chapter, and proposed any mitigation is listed in Section 9.9.
Natural England	Scoping Opinion, October 2021 Appendix 2 Natural England response	The development is in proximity to the Holderness Inshore MCZ. The ES should consider including information on the impacts of this development on MCZ interest features, to inform the assessment of impacts on habitats and species of principle importance for this location.	The nearest MCZ (Holderness Inshore) is located approximately 20 km from the proposed development and does not overlap with the zone of influence. Furthermore, there are no mobile FOCI that could overlap with any of the marine effects resulting from the proposed development. Overall, therefore, there is considered to be no potential for direct or indirect impacts on FOCI of this site. On this basis an MCZ Assessment is not considered to be required.
Natural England	Scoping Opinion, October 2021 Appendix 2 Natural England response	The EIA will need to consider any impacts upon local wildlife and geological sites. The assessment should include proposals for mitigation of any impacts and if appropriate, compensation measures.	The assessment has considered potential effects on local sites. Potential effects on nature conservation destinations are considered further in Section 9.8 and mitigation in Section 9.9.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
Natural England	Scoping Opinion, October 2021 Appendix 2 Natural England response	The ES should also assess the impact of all phases of the proposal on marine protected species (including, for example, pinnipeds (seals), cetaceans (including dolphins, porpoises whales), fish (including seahorses, sharks and skates), marine turtles, marine invertebrates etc.).	Relevant protected marine species (such as marine mammals and certain fish species) have been considered within the impact assessment (Section 9.8).
Natural England	Scoping Opinion, October 2021 Appendix 2 Natural England response	The ES should thoroughly assess the impact of the proposals on habitats and/or species listed as 'Habitats and Species of Principal Importance' within the England Biodiversity List, published under the requirements of S41 of the Natural Environment and Rural Communities (NERC) Act 2006. Consideration should also be given to those species and habitats included in the relevant Local BAP.	Habitats and/or species listed as 'Habitats and Species of Principal Importance'/BAP have been considered within the impact assessment (Section 9.8).
Natural England	Scoping Opinion, October 2021 Appendix 2 Natural England response	The development should seek if possible to avoid adverse impact on sensitive areas for wildlife within the site, and if possible provide opportunities for overall wildlife gain.	A number of mitigation measures have been identified to reduce potential adverse impacts on marine ecology receptors and are described in more detail Section 9.9.
Natural England	Scoping Opinion, October 2021	In June Government announced their response to the Dasgupta review which introduced amendments to the Environment Bill. A key feature of this	As an NSIP, this project is not subject to the requirement to deliver 10% BNG under The Environment Act 2021, in that the obligation is yet to come into force.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
	Appendix 2 Natural England response	announcement is the amendment to require Nationally Significant Infrastructure Projects (NSIPs) to deliver a 10% BNG outcome. The changes to bring these projects into scope for mandatory BNG is reliant on the timing of the Environment Bill, and until amendments have been made to National Policy Statements for all scenarios net gain remains voluntary. However, Natural England considers that major infrastructure developments should set the highest environmental standards and deliver significant gains. The Biodiversity Metric 3.0 (Natural England) has been developed as a tool for 'Biodiversity accounting' and should be used by the developer to assess the biodiversity impact of the development.	As per subsequent Natural England advice during statutory consultation (summarised in this table), the Defra metric should not be used to assess impacts and calculate compensation for habitat damage or loss in designated sites or irreplaceable habitat.
North Lincolnshire Council Natural Environment Policy Specialist	North Lincolnshire Council scoping response, 28 October 2021	For the in-combination assessment within the HRA, it is advised the applicant makes use of the Humber Nature Partnership In-combination Database.	The database has been reviewed, and used as advised, for the in-combination assessment within the HRA (Application Document Reference 9.6).
North East Lincolnshire Council Ecologist	North East Lincolnshire Council scoping response, 23 November 2021	I can confirm that I'm happy with [the approach set out in the Scoping Report]. Interest will lie in the HRA, but protected species and habitats outside of the qualifying features of the	A HRA has been undertaken alongside the ES (Application Document Reference 9.6).

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		Humber Estuary designation have been dealt with here.	
Royal Society for the Protection of Birds (RSPB)	Pre-application meeting, 12 November 2021	A discussion was had on the proposed development, bird survey data, and cumulative effects.	A description of bird survey data is provided in Section 9.3 and 9.6 of this chapter. An assessment of cumulative effects is provided in the ES (Chapter 20).
Natural England (PI40)	Statutory Consultation 19/01/22 - 23/02/22	*Internationally and nationally designated sites:* The consultation documents do not include a Habitats Regulations Assessment (HRA). It is Natural England's advice that the proposal is not directly connected with or necessary for the management of the European site. You should therefore determine whether the proposal is likely to have a significant effect on any European site, proceeding to the Appropriate Assessment stage where significant effects cannot be ruled out.	A HRA has been undertaken alongside the ES (Application Document Reference number 9.6).
Natural England	Statutory Consultation 19/01/22 - 23/02/22	Based on our current understanding of the nature and scale of the development, and the information provided within the consultation, Natural England broadly agrees with the scope of the assessment set out in Table 9.17 and Table 9.19, within Chapter 9 of the PEIR. However, further justification is needed where impact pathways have been scoped	More detailed information on potential effects during the operation phase has been included in Table 9.25 of this chapter to address this. A HRA has been undertaken alongside the ES (Application Document Reference number 9.6).

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		out of further assessment for the operation phase, while the same impact pathway has been scoped in for the construction phase. This is discussed in more detail in the sections below. We recommend you consider potential likely significant effects on international designated sites arising from the impact pathways identified in Table 9.17 and Table 9.19, in addition to any other potential impact pathways identified within this consultation response and during your assessment.	
Natural England	Statutory Consultation 19/01/22 - 23/02/22	We note that Table 9.1 refers to sensitivity as 'moderate' while section 9.3.12 defines it as 'medium'. Natural England recommends using terms consistently to avoid potential confusion.	The terminology employed has now been made consistent in the ES.
Natural England	Statutory Consultation 19/21/22 - 23/02/22	Table 9.1 summarises the sensitivity level of marine ecology receptors. Natural England does not consider that enough detail has been included in this table. We would expect to see sensitivity characterised in more depth in the text. For example, marine mammal sensitivity to underwater noise could vary depending on the	Further rationale for the sensitivity levels that have been assigned are included for each pathway in the impact assessment (Section 9.8).

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		pathway being assessed e.g. disturbance versus injury.	
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of loss of intertidal and subtidal habitat:* Natural England notes that the proposed development will result in a loss of 1.65 ha of intertidal habitat as a result of the proposed capital dredge and jetty. In addition, it is assumed that there will be a loss of subtidal habitat as a result of piling associated with the proposed floating pontoons and finger pier structures. The potential for loss of subtidal habitat has not been considered in the PEIR. Natural England advises that the HRA considers the potential for likely significant effects as a result of loss of both intertidal and subtidal habitat. This should include loss of SAC habitat (i.e. Estuaries and Mudflats and sandflats not covered by seawater at low tide) as well as the loss of supporting habitat for SPA bird species.	A HRA has been undertaken alongside the ES (Application Document Reference number 9.6). Both the ES and HRA have considered intertidal and subtidal loss including effects on designated features. The loss of intertidal habitat as a result of the proposed development is considered *de minimis* in extent (0.012 ha direct loss and 0.01 ha indirect loss). This is following optimisation of the scheme design in order to reduce the loss and consequently is not considered to result in an adverse effect on site integrity.
Natural England	Statutory Consultation 19/01/22 - 23/02/22 .	*Assessment of loss of intertidal and subtidal habitat:* Natural England considers that any credible risk of a measurable loss of marine or terrestrial habitat, no matter how small, from within a European site is a 'likely	The HRA (Application Document Reference number 9.6) has assessed the potential for an adverse effect on site integrity as a result of the proposed development.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		significant effect' and the full significance of its impact on site integrity should be screened-in and further tested by an Appropriate Assessment. It is Natural England's advice that a lasting and irreparable loss of European Site habitat will prevent a conclusion of no adverse effect on site integrity being reached unless an Appropriate Assessment can clearly ascertain otherwise.	The loss of intertidal habitat as a result of the proposed development is considered *de minimis* in extent (following a change to the scheme design in order to reduce the loss) and consequently is not considered to result in an adverse effect on site integrity.
Natural England	Statutory Consultation 19/01/22. - 23/02/22	*Assessment of loss of intertidal and subtidal habitat:* We note that section 9.8.172 states that, in the context of the Humber Estuary SPA, the loss of 1.65 ha of intertidal habitat as a result of the proposed development is considered negligible. Natural England advises that further assessment is required within an Appropriate Assessment.	The HRA (Application Document Reference number 9.6) has assessed the potential for an adverse effect on site integrity as a result of the proposed development. The loss of intertidal habitat as a result of the proposed development is considered *de minimis* in extent (following a refinement to the scheme design) and consequently is not considered to result in an adverse effect on site integrity.
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Appropriate Assessment:* An appropriate assessment should be made in view of the European sites' conservation objectives, which provides a list of attributes contributing to site integrity that can provide a checklist for the assessment process, the detailed supplementary advice and	An HRA has been undertaken in view of the European sites' conservation objectives and with the supplementary advice and advice on operations used to inform the assessment (Application Document Reference 9.6).

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		advice on operations should also inform the conclusion.	
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on benthic habitats and species:* At this time, Natural England have not fully considered the potential impacts on benthic habitats and species due to lack of expertise availability and we will provide detailed comments on the ES.	Noted.
Natural England	Statutory Consultation 19/01/22- 23/02/22	*Assessment of impacts on benthic habitats and species:* During the construction phase, potential changes to benthic habitats and species as a result of the proposed capital dredge have been scoped in, on the basis that dredging could result in changes in species' abundance and distribution through damage, mortality or relocation to a disposal site. It is not clear why the same impact pathway has been scoped out for the proposed maintenance dredging. In addition, Table 9.19 acknowledges that the predicted impacts on benthic ecology receptors as a result of maintenance dredging could be equivalent to the predicted impacts as a result of the capital dredge regime. We consider that changes in species' abundance and distribution are also possible	More detailed information on potential effects has been included in Table 9.25 of this chapter.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		during the maintenance dredging through the same mechanisms identified for the capital dredge. Therefore, please provide further justification for your rationale on this impact pathway.	
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on fish:* At this time, Natural England have not fully considered the potential impacts on fish species due to lack of expertise availability. We will provide detailed comments on the ES. We note however that the assessment has correctly identified fish species included in the Humber Estuary SAC designation; namely sea lamprey *Petromyzon marinus* and river lamprey *Lampetra fluviatilis*. When assessing the likely significant effect on the SAC, Natural England advises you have consideration for the potential impacts on lamprey species at the different life stages.	A HRA has been undertaken alongside the ES (Application Document Reference number 9.6). This considers the impact on lamprey at different life stages.
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on fish:* As outlined above, under "*Assessment of impacts on benthic habitats and species*", it is not clear why impact pathways for maintenance dredging have been scoped out while the same	More detailed information on potential effects during operation/maintenance dredging, and which impact pathways are assessed in detail, has been included in Table 9.25 of this chapter.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		impact pathways have been assessed for capital dredging. Either further justification should be provided, or this impact pathway should be assessed.	
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on fish:* The justification included in Table 9.19 for underwater noise disturbance from vessel operations states that the impact pathway has been "…*scoped into the assessment*". However, the impact pathway appears to have been scoped out of the assessment. This should be clarified.	This pathway has been scoped out of the assessment. A detailed rationale has been included in Table 9.25 of this chapter.
Natural England	Statutory Consultation 19/01/22- 23/02/22	*Assessment of impacts on fish:* Section 9.8.130 states that works will take place between 7 am and 7 pm, therefore reducing the risk to migratory fish. This has not been included as mitigation in section 9.9. It is our advice that night time working is beneficial to lamprey species and therefore should be considered mitigation.	River lamprey migrate at night (Environment Agency, 2013) and so it is assumed that the Natural England statement 'It is our advice that night time working is beneficial to lamprey species and therefore should be considered mitigation' is an error. Restricting piling at night is proposed as a mitigation measure (see Section 9.9).
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on marine mammals:* While we agree with the scope of the assessment, we consider that it could benefit from greater quantification of the impact parameters. For example, when considering potential collision risk, it	Potential collision risk including vessel speeds and the number of vessel movements is considered in more detail in Tables 9.21 and Table 9.25.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		would be helpful to consider typical vessel speeds and the number of vessel movements. We do not consider habituation provides sufficient justification for scoping out collision risk. Marine mammals are highly mobile and will not remain only in the Humber Estuary. Therefore, they will not necessarily be habituated to the level of vessel presence here.	
Natural England	Statutory Consultation 19/01/22-23/02/22	*Assessment of impacts on marine mammals:* Natural England advises that the assessment should also consider potential barrier effects caused by underwater noise. This should include consideration of whether marine mammals are excluded from certain areas as a result of the proposed development, and whether this exclusion limits their normal movements.	Potential barrier effects caused by underwater noise including displacement effects are considered in more detail in the assessment (paragraph 9.8.195).
Natural England	Statutory Consultation 9/01/22-23/02/22	*Assessment of impacts on marine mammals:* The stated impact pathway being assessed in section 9.8.144 is “disturbance”. However, the assessment presented only considers permanent threshold shifts (PTS) and temporary threshold shifts (TTS), which are both types of auditory impact, and do not necessarily	There are no equivalent behavioural response criteria that would represent the sources of underwater noise associated with the proposed development. Behavioural responses are less predictable and difficult to quantify as reactions are highly variable and context specific. The assessment, therefore, includes a review of the behavioural responses of marine mammals to different

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		correspond directly to disturbance or behavioural responses. In the case of PTS specifically, we consider this to be an injury, not a form of disturbance.	activities from published field studies (Section 9.8).
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on marine mammals:* Section 9.8.150 refers to "*a review of the available evidence on the behavioural responses*" of marine mammals in Appendix 9.2. We advise that information from this review should be included in the main body of the ES. In particular, it should include any identified disturbance and behavioural impact ranges. There should also be a separate assessment of the impact significance of disturbance. This is particularly important as disturbance effects cannot be mitigated in the same way as injury effects.	The review on behavioural responses has been included in the main body of the ES in the 'General Scientific Context' section of the underwater noise effects during construction pathway (paragraphs 9.8.175 to 9.8.186). However, it is worth noting that existing evidence is typically from the larger tubular piles used in offshore windfarms or other activities such as seismic survey. Evidence on the behavioural responses of marine mammals to small percussive driven piles in port or harbour areas is limited and therefore it is not possible to provide a conclusive assessment of the significance of potential disturbance effects.
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on marine mammals:* The ES should include information on the distance between the proposed works (including any possible vessel transits due to dredge disposal) and seal haul out sites. If the works or vessel transits are close enough to any haul outs so that disturbance might occur, then the impact of disturbance due to physical	The proximity to seal haul out sites is considered further in Table 9.21 and Table 9.25 of this chapter.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		presence of the vessel should also be considered.	
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on marine mammals:* The justification included in Table 9.19 for underwater noise disturbance from vessel operations states that the impact pathway has been "…*scoped into the assessment*". However, the impact pathway appears to have been scoped out of the assessment. This should be clarified.	This pathway has been scoped out of the assessment. A detailed rationale has been included in Table 9.25 of this chapter.
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on marine mammals:* Natural England does not agree with the justification provided for screening out underwater noise disturbance when the same impact pathway has been screened into the assessment for construction. Table 9.19 acknowledges that the magnitude of potential impact of maintenance dredge and disposal could be "equivalent" to the magnitude of potential impact of capital dredge and disposal. Further, based on the information provided in the consultation, Natural England understands ambient noise conditions are up to 154 dB SPL RMS, while the cargo ships are up to 184 dB SPL RMS. Therefore, we do not agree that	The outcomes of the assessment of underwater noise disturbance from capital dredging activities during construction will be the same for maintenance dredging activities during operation. A worst-case source level for all types of dredgers has been applied to the underwater noise assessment and, therefore, the predicted ranges of effect are applicable to both the maintenance and capital dredging activities. In summary, there is not considered to be any risk of injury or significant disturbance to marine mammals from any dredging activities that are proposed at the Port of Immingham even if the dredging were to take place continuously 24/7.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		the noise levels are unlikely to be discernible above ambient levels. It is our advice is that underwater noise disturbance during operation should be included in the assessment, although we anticipate that the outcome of the assessment may not be significant.	
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on marine mammals:* For clarity, we also advise that collision risk is included in Table 9.19 even if suitable justification for it to be scoped out is provided.	This pathway has been scoped out of the assessment. A detailed rationale has been included in Table 9.25 of this chapter.
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on marine mammals:* Natural England welcomes the mitigation measures outlined in section 9.9.4.	Noted.
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on coastal waterbirds:* Chapter 9 of the PEIR outlines the data and information sources used to inform the assessment of the potential impacts of the development. This includes the existing Immingham Outer Harbour (IOH) ornithology surveys. As the surveys that relate to IOH development have previously covered the period October to March, Natural England welcomes inclusion of recent surveys to cover the Autumn passage period (August – September). We	Passage surveys have been undertaken on a weekly basis in March and April 2022 and will also be undertaken on a weekly basis from September to November 2022 (summarised in Section 9.6).

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		advise that these surveys should also be extended to include the full Spring passage period (i.e., to April). Weekly visits between September and November, and March and April inclusive, are recommended due to high turnover of birds during migration.	
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on coastal waterbirds:* Natural England welcomes Figures 9.9 and 9.10 showing the mean peak number of birds during different months and the distribution of roosting and foraging birds in Sector B. In order to fully understand the potential impacts on coastal waterbirds, it might be useful to also provide data to demonstrate how the birds are using the area during different tidal states.	Information on how the birds are using the area during different tidal states has been provided in the baseline (Section 9.6 of this chapter).
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on coastal waterbirds:* Table 9.16 indicates that SPA qualifying species have been highlighted in bold. It is not clear why some species are not highlighted; curlew, grey plover, mallard and teal are all important component species of the Humber Estuary SPA waterbird assemblage feature. Impacts to all the SPA bird species, whether they are individually qualifying features or as	Species listed as SPA assemblage species within the citation have been highlighted in in Table 9.19 with the symbol †. The HRA (Application Document Reference 9.6) considers all SPA bird species which are present on the project site in numbers over 1% of the estuary population. However, for SPA species where only one single bird observation represents > 1% of the estuary population (based on the data for Sector B

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		part of the waterbird assemblage should be assessed within the HRA. As a guideline, impacts on all SPA bird species which are present on the project site in numbers over 1 per cent of the estuary population (not just over 10 per cent) have the potential to undermine the conservation objectives and should therefore be subject to further assessment in the HRA.	presented in Table 9.19 of this chapter), such as Greenshank, they are not considered further in the assessment.
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on coastal waterbirds:* Natural England agrees with the scope of assessment of potential impacts to coastal waterbirds during construction and advises that the potential impact pathways included in Table 9.17 should be considered in the HRA.	These pathways are considered in the HRA (Application Document Reference number 9.6).
Natural England	Statutory Consultation 19/01/22-23/02/22	*Assessment of impacts on coastal waterbirds:* Section 9.8.228 discusses the potential for operational disturbance to coastal birds using the nearby intertidal mudflat as a result of vessel movements and people around the berthing infrastructure. Natural England advises that the assessment should also consider the potential for disturbance as a result of wheeled cargo moving from the berthing infrastructure to the terminal areas,	Vehicles moving from the berthing infrastructure to the terminal areas have been considered within the assessment (Section 9.8). This pathway is also considered in the HRA (Application Document Reference number 9.6).

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		which are expected to occur directly above and adjacent to the intertidal mudflat.	
Natural England	Statutory Consultation 19/01/22 - 23/02/22	As discussed in the sections relating to benthic habitats and species and marine mammals, it is not clear why potential disturbance impacts as a result of maintenance dredging has not been considered in the scoping of operation impacts when it has for construction. Natural England advises that this should be considered further.	Detailed information on potential effects during operation/maintenance dredging has been included in Table 9.25 of this chapter.
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on coastal waterbirds:* We welcome the proposed avoidance/mitigation measures set out in section 9.9. The specifics of these measures should be detailed in the Code of Construction Practice (CoCP) and Ecological Management Plan (EMP) which will need to be agreed with Natural England.	Mitigation measures are detailed within the Construction Environmental Management Plan (CEMP) (Application Document Reference number 9.2).
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on coastal waterbirds:* Section 9.9.6 identifies mitigation measures to reduce disturbance to coastal waterbirds during construction, namely soft start piling and cold weather restrictions. Please note that these mitigation measures rely on availability of alternative intertidal areas for feeding	The availability of alternative intertidal areas for feeding and roosting birds is considered in Section 9.8 and in the HRA (Application Document Reference number 9.6).

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		and roosting birds. This should be considered in more detail within the Appropriate Assessment.	
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Assessment of impacts on coastal waterbirds:* Section 9.9.8 proposes an adaptive monitoring and management strategy to address disturbance of waterbirds during the operational phase. Whilst it would be interesting to see the results of a programme of monitoring of disturbance related to port operations, Natural England does not recommend reliance on a 'monitor and manage' approach which we have found can be very difficult to implement. There are a number of issues such as the setting of appropriate targets when additional mitigation measures would be required and separating out the disturbance effects of this development from current port activity. The surveys are proposed to take place twice per month, so provide a 'snap shot' of port activity, which may miss a very disturbing event, which would trigger additional mitigation measures. This aspect should be considered in more detail within the Appropriate Assessment and additional mitigation	The application of an adaptive monitoring and management strategy has not been included in the ES given Natural England's concerns relating to the implementation of such a strategy. Instead, screens will be used to reduce potential disturbance on a precautionary basis during operation (Section 9.9 of this chapter). If mitigation was deemed necessary as part of an adaptive approach, it is likely that this would have involved the implementation of screens.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		measures proposed, if it cannot be shown that there will not be an adverse effect on the integrity of the designated site.	
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Nationally designated sites: Sites of Special Scientific Interest (SSSIs):* Natural England notes that the application site is in close proximity to the Humber Estuary SSSI and North Killingholme Haven Pits SSSI. Based on the plans submitted, Natural England considers that the proposed development could have potential significant effects on the interest features for which the sites have been notified. Our advice regarding the potential impacts upon the Humber Estuary SSSI coincides with our advice regarding potential impacts upon the Humber Estuary SAC/SPA/Ramsar as detailed above. Natural England note there are a number of additional designated sites within proximity to the application site which may require assessment for potential air quality impacts. Detailed	Potential effects on SSSIs are discussed in Section 9.8 of the chapter. Impacts to ecological receptors due to changes in air quality are assessed in Chapter 13 (Air Quality).

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		modelling will determine those sites which are relevant to the assessment.	
Natural England	Statutory Consultation 19/01/22 - 23/02/22	Agree with the conclusions of the PEA and welcome the proposed avoidance/mitigation measures and pre-construction checks set out in the PEA.	Noted.
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Environmental and Biodiversity Enhancement:* Further details of the ecological enhancements that are proposed will be provided as part of the DCO submission and we would welcome inclusion of such detail.	Further details on ecological enhancements as part of the IERRT project are provided in Chapter 2 (Proposed Development).
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Environmental and Biodiversity Enhancement:* As an NSIP, the project does not fall directly within the remit of the national policy requirement within The Environment Bill to deliver 10 per cent BNG. However, the Government has committed to amending the Environment Bill to include mandatory BNG for NSIPs down to mean low water.	At this time, the requirement for NSIPs to deliver 10% BNG under The Environment Act 2021 has not come into effect as referenced above.
Natural England	Statutory Consultation 19/01/22 - 23/02/22	*Environmental and Biodiversity Enhancement:* Please be advised that the Defra metric should not be used to assess impacts and calculate compensation for habitat damage or loss in designated sites or irreplaceable habitats. Any impacts on	Noted.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		such habitats and sites should be assessed in accordance with planning policy and via environmental assessments, such as an Appropriate Assessment where European sites are concerned, with any necessary mitigation or compensation requirements dealt with separately from BNG provision.	
Natural England	Pre-application meeting, 7 February 2022.	The meeting provided an overview of the IERRT project, the marine ecology assessment approach, the site-specific surveys and a discussion on potential impacts relating to habitat loss/change and bird disturbance. As part of the meeting ABP highlighted that they will continue to optimise the marine design (dredge berth pocket) and layout of marine infrastructure with a view to avoiding or at least minimising any loss of intertidal habitat. Natural England suggested that potential mitigation for bird disturbance could involve opportunities for reducing activities that are causing disturbance elsewhere on the Humber as this could potentially make other areas of the estuary more attractive to birds.	The scope of the environmental assessments has been completed taking on board consultee comments from the meeting including in the HRA (Application Document Reference number 9.6).

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
Natural England	Pre-application meeting, 16 March 2022.	The meeting provided an update of the IERRT project, a summary of the future site-specific surveys and a discussion on potential impacts relating to habitat loss/change and bird disturbance. Proposed mitigation measures in construction and operation for potential bird disturbance were also discussed.	The assessments including in the HRA (Application Document Reference number 9.6) have been completed taking on board consultee comments from the meeting.
Natural England	Pre-application meeting, 28 April 2022	The meeting provided a further update of the IERRT project as well as a discussion on potential impacts relating to habitat loss/change and bird disturbance.	This chapter and the HRA (Application Document Reference number 9.6) have been completed taking on board consultee comments from the meeting.
Natural England	Pre-application meeting, 28 July 2022	The meeting provided a further update of the IERRT project as well as a discussion on potential impacts relating to habitat loss/change and bird disturbance. Proposed mitigation measures to reduce bird disturbance were also discussed.	This chapter and the HRA (Application Document Reference number 9.6) have been completed taking on board consultee comments from the meeting.
Natural England	Natural England response to pre-application meeting minutes (28 July 2022), 3 October 2022	Natural England provided comments following the meeting held on 28 July 2022 and the meeting minutes.	The environmental assessments have been completed taking on board comments raised in Natural England's response.
MMO (PI35)	Statutory Consultation	*Benthic Ecology:* The assessment undertaken at the PEIR stage is sufficiently robust and proportionate to	Noted.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
	19/01/22 - 23/02/22	fully identify and assess the project's potential impacts on benthic ecology.	
MMO	Statutory Consultation 19/01/22 - 23/02/22	*Benthic Ecology:* It is evident from the results of the project-specific intertidal survey that the intertidal habitats in this region and the benthic invertebrates which inhabit them represent a potentially very valuable food source for birds and potentially fish. This is based on the numbers and biomass of the assemblages sampled. While the key taxa have each been split into two size classes and the numbers of each in each of these two are presented, the MMO, in consultation with Cefas, query whether this could be further developed by basing this on biomass as biomass is possibly a better criterion upon which to base estimates of prey availability. Therefore, presenting the biomass of these taxa into the two size classes might be more suitable. These biomass values could also be presented as estimates of secondary productivity for a more pertinent proxy of bird prey. Additionally, some bird species may be more selective of their prey, and thus some assessment of which bird species are likely to be more affected	Biomass for the different size classes has also been added to the table (Table 9.12) and discussed in the context of waterbirds in paragraph 9.6.27.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		by the change in prey availability may be worthwhile.	
MMO	Statutory Consultation 19/01/22 - 23/02/22	*Fisheries and Fish Ecology*: Advice following the scoping report recommended that the limitations of data sources used (e.g., gear selectivity and the timing of surveys) be acknowledged. However, this could not be found within this chapter or the PEIR document. Section 9.10 Limitations refers to assumptions being used in the assessment, rather than limitations of the data itself. Therefore, it is recommended that limitations of the data sources used be discussed in the ES.	Limitations of fish survey data (including gear selectivity and timings of the surveys) which have been used to characterise fish assemblages in the Immingham area is discussed in Section 9.6 of this chapter.
MMO	Statutory Consultation 19/01/22 - 23/02/22	*Fisheries and Fish Ecology:* It is noted that as a result of the preliminary assessment of potential impacts to fish receptors, all potential impacts during operation (i.e., changes to fish populations and fish habitat, changes in water and sediment quality and underwater noise and vibration) have been scoped out for further assessment as these impacts are considered to be equivalent or lower in magnitude than those from the existing maintenance dredging and vessel movements. We have no major	Detailed information on potential effects during operation has been included in Table 9.25 of this chapter. Habitat loss and disturbance as well as underwater noise impacts on fish during operation taking into account other developments in the area is considered within Chapter 20 (Cumulative and In-Combination Assessment) of the ES.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		concerns that operation activities would significantly impact fish populations when compared with current noise levels generated by the existing vessel traffic in the Humber. However, habitat loss and disturbance as well as underwater noise impacts on fish during operation should be assessed further within the ES, taking into account other developments in the area.	
MMO	Statutory Consultation 19/01/22 - 23/02/22	*Fisheries and Fish Ecology:* The report states that dredging activities will be undertaken 24 hours per day for approximately 100 days, however the period of the operation, i.e., the months in which dredging works are expected to take place within the River Humber and Estuary have not been specified. Changes in the water column during capital dredging, and dredge and disposal may cause temporary potential impacts to sensitive fish receptors such as larvae and juvenile fish as well as to migratory species such as salmonids. Therefore, there are concerns regarding a prolonged disturbance and potential impacts to migratory species in their up/downstream movements	Potential effects on fish during construction due to water quality and underwater noise ae considered within the assessment (paragraphs 9.8.125 to 9.8.173). The assessment has been based on the precautionary assumption that the works could occur at any time of year as a worst case. Piling restrictions to avoid sensitive periods for migratory fish have been discussed with the MMO and Cefas and are set out in Section 9.9.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		during migratory seasons (e.g., smelt and salmon), as a result of increased suspended sediment concentrations, poor water quality and underwater noise causing an acoustic barrier to fish movement. It is recommended, therefore, that, in the ES, an estimate of the timing and duration of the proposed works is presented in order to identify possible seasonal constraints in relation to any overlap with the spawning and migratory periods for those sensitive and protected species.	
MMO	Statutory Consultation 19/01/22 - 23/02/22	*Fisheries and Fish Ecology:* The use of vibro-piling still has the potential to generate an acoustic barrier and may impact migratory fish. Whilst soft start measures may allow resident species to leave the area of greatest disturbance, such measures may not necessarily be appropriate or of benefit for migratory species, when the primary concern is that noise may create a temporary acoustic barrier in the river, impeding travel and migration.	As detailed in the underwater noise assessment (paragraphs 9.8.154 to 9.8.173), the scale of the acoustic barrier during vibro-piling is much less than during impact piling. During vibro-piling, behavioural reactions are anticipated to occur across 48% of the width of the estuary at low water and 33% of the estuary width at high water. Furthermore, vibro piling will not be a continuous activity and will only take place up to 20 minutes per working day (equivalent to around 1% of the construction week).
MMO	Statutory Consultation	*Fisheries and Fish Ecology:* Exact dates of the proposed works have not been provided. Therefore, concerns	The main periods when fish are migrating through the estuary are highlighted in Table 9.16 of this chapter. The assessment has

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
	19/01/22 - 23/02/22	remain that significant impacts to fish are likely to occur during the sensitive fish spawning and migratory periods in the Humber. Consequently, a detailed description of sensitive seasons for fish species known to migrate through the area where the works are proposed should be provided and should be used to consider any overlap with the proposed dates for piling and dredging works.	been based on the worst-case precautionary assumption that the works could occur at any time of year.
MMO	Statutory Consultation 19/01/22 - 23/02/22	*Shellfisheries*: The assessment undertaken at the PEIR stage is sufficiently robust and proportionate to fully identify and assess the project's potential impacts on shellfish. Considering the location and data considered, the MMO, in consultation with Cefas, agree that commercial shellfisheries be scoped out of the assessment.	Noted.
MMO	Statutory Consultation 19/01/22 - 23/02/22	*Underwater noise:* Primary impacts associated with underwater noise during the construction phase have been considered. Given the location and proposed activities, the MMO, in consultation with Cefas, consider that potential displacement and acoustic barriers to migration are likely to be the main potential impacts of concern.	Noted. Potential displacement and acoustic barriers to migration are considered in the assessment (paragraphs 9.8.157 to 9.8.162).

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
MMO	Statutory Consultation 19/01/22 - 23/02/22	*Fisheries and Fish Ecology:* The MMO, in consultation with Cefas, cannot agree with the significant levels of the assessment presented in relation to underwater noise impacts on fish receptors from both dredging and dredge and disposal works, and piling works.	Responses to specific concerns with respect to the assessment of significance levels in relation to underwater noise impacts on fish receptors are provided in this table in the following two rows.
MMO	Statutory Consultation 19/01/22 - 23/02/22	*Fisheries and Fish Ecology:* The MMO, in consultation with Cefas, are not confident with the appropriateness of the assumption that fish swim passively with tidal flows as a worst case scenario. For instance, exposure times would be different (i.e., higher) for migratory fish species swimming against tidal flow in their up or downstream migration or for those waiting in 'refuge areas' so that they do not expend energy to wait for the right tidal flow to migrate up or downstream. Therefore, assuming that fish swim passively is too simplistic and not an accurate representation of the worst-case scenario as it would be worse if fish swim actively against the tidal flow on their way to spawning and nursery grounds which may lead to moving towards the source of noise, and this is very time dependent.	Noted. The assessment has been undertaken on the basis that the piling and dredging works could be undertaken at any time of year representing the worst case scenario. Piling restrictions to avoid sensitive periods for migratory fish have been discussed with the MMO and Cefas and are set out in Section 9.9 of this chapter.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		Consequently, the level of impacts from underwater noise on migratory fish would be determined by the exact timing when the works are undertaken. Therefore, it is recommended that an estimate of the timing and duration of the proposed works (i.e., months) is provided to identify possible seasonal constraints in relation to any overlap with the spawning and migratory periods for those sensitive and protected species.	
MMO	Statutory Consultation 19/01/22 - 23/02/22	*Fisheries and Fish Ecology:* The overall impacts will depend on the final timing and duration (i.e., specific months) of the piling, dredging and disposal works in relation to the sensitive seasons for fish in the vicinity of the works. Therefore, a detailed description of the sensitive seasons of fish species known to migrate through the area where the works are proposed in relation to the proposed dates for piling and dredging works should be provided.	The main periods when fish are migrating through the estuary are highlighted in Table 9.16 of this chapter. The assessment has been undertaken on the basis that the piling and dredging works could be undertaken at any time of year representing the worst case scenario.
MMO	Pre-application meeting, 24 February 2022.	The meeting provided an overview of the IERRT project, a summary of the assessment approach surveys and a discussion on acoustic modelling used to inform the underwater noise	The scope of the environmental assessments has been completed taking on board consultee comments from this meeting.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		assessment on fish. Potential mitigation measures for fish with respect to underwater noise were also discussed.	
MMO and Cefas	Pre-application meeting, 7 April 2022.	The meeting provided an update on the IEERT and focused on discussing comments received from the MMO and Cefas on the PEIR with respect to the acoustic modelling used to inform the underwater noise assessment on fish and potential effects on migratory fish species.	The scope of the environmental assessments has been completed taking on board consultee comments from this meeting.
MMO and Cefas	ABPmer technical note, 21 April 2022 MMO/Cefas response to technical note, 18 May 2022 ABPmer technical note, 13 June 2022 MMO/Cefas response to technical note, 20 September 2022	A technical note on the proposed mitigation measures for migratory fish was prepared by ABPmer and issued to the MMO on 21 April 2022. Further comments and advice from the MMO and Cefas were received on 18 May 2022, and these have been taken into consideration in the environmental assessment. A second technical note on the proposed piling restrictions for migratory fish was prepared by ABPmer and issued to the MMO on 13 June 2022. The key information included within the technical note has been incorporated into the ES assessment. Further comments and advice from the MMO and Cefas were received on 20 September 2022.	The approach to the proposed mitigation measures relating to piling and underwater noise, set out in Section 9.9 of this chapter, has been developed in consultation with the MMO and Cefas.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
	Pre-application meeting, 3 October 2022 (including pre-meeting briefing note, 30 September 2022, post-meeting note, 8 November 2022)	A meeting was held with the MMO and Cefas to discuss the evidence and piling restrictions (pre- and post-meeting notes were also issued).	
MMO and Cefas	MMO/Cefas letter, 1 December 2022	Inclusion of appropriate temporal restrictions for both percussive piling and vibro-piling should be addressed.	Section 9.9 of this chapter details the seasonal restrictions on the duration of percussive piling activity that are proposed as mitigation for the IERRT project. The effects of vibro-piling on migratory fish are not considered to be significant and do not need to be mitigated. This is further explained in Section 9.8 of this chapter and in Appendix 9.2 to this ES.
		Clear justification should be provided for the proposed night time piling restriction dates together with an explanation of why piling restrictions should only be applied at night and only to percussive piling in respect of each relevant fish species.	Section 9.9 of this chapter sets out the justification for the proposed night time piling restriction dates. Seasonal piling restrictions on the duration of percussive piling activity between specified dates are also proposed as mitigation for the IERRT (which are not just applied at night). The effects of vibro-piling on migratory fish are not considered to be significant and do not need to be mitigated.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
			This is further explained in Section 9.8 of this chapter and in Appendix 9.2 to this ES.
		Explanation required of why the timing of the proposed piling restrictions outlined do not correlate with the timing of those used for Able Marine Energy Park (AMEP), which are referenced as an example of best practice in the estuary.	The proposed restrictions (set out in Section 9.9 of this chapter) take account of the fact that the underwater noise levels associated with the piling for IERRT (and effects on migratory fish) are less than for the AMEP development. This is in particular due to the following: - The maximum pile diameter of the piles required for IERRT is anticipated to be 1.422 m whereas for AMEP the maximum pile diameter size is 2.54 m and therefore the levels of noise generated at the source of piling will be significantly less for IERRT compared to AMEP; - The piling required for AMEP will result in an acoustic barrier across the entire width of the estuary whereas a partial acoustic barrier is predicted for IERRT given the smaller size of the piles, as well as the fact that IERRT is located downstream and in a slightly wider part of the estuary; - The duration of the piling works is approximately 24 or 37 weeks for IERRT compared to a minimum 2-year construction programme for AMEP; and - The marine piling required for the AMEP involves construction of a continuous pile wall. This requires less time between each

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
			pile being driven for set up/mobilisation of the piling rig. The piling required for the IERRT project will involve a significant amount of time to set up between each pile being driven, meaning the piling rate per day will be lower than AMEP.
		Assessment of concurrent dredging and piling activities required during construction in the inter-related and cumulative impacts assessment.	An assessment of intra-project cumulative and in-combination effects is provided in Chapter 20 of this ES. This includes consideration of the effects of concurrent dredging and piling activities on fish.
		Assessment of the effects of noise and vibration from piling operations (including any additional piling from recent changes in project design) to be included in the nature conservation and marine ecology chapter.	An assessment of the effects of underwater noise and vibration from piling operations (including effects from recent project design changes) is provided in Section 9.8 of this chapter.
Environment Agency (PI34)	Statutory Consultation 19/01/22 - 23/02/22	We have considered this Chapter of the preliminary assessment for elements of marine ecology, which fall under the Environment Agency's remit. We agree with the scoped in elements of Table 9.17, which are being taken forward in the assessment. We note that there will be a loss of 1.64 ha of intertidal habitat, which has been identified as high to moderate vulnerability, and acknowledged for its importance to supporting coastal birds. The Environment Agency strongly	The HRA (Application Document Reference number 9.6) has assessed the potential for an adverse effect on site integrity as a result of the proposed development. The loss of intertidal habitat as a result of the proposed development is considered *de minimis* in extent (0.012 ha direct loss and 0.01 ha indirect loss) following optimisation of the scheme design in order to reduce the loss and consequently is not considered to result in an adverse effect on site integrity. On this basis, compensatory habitat is not required.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		encourages compensation for this loss.	
Environment Agency	Statutory Consultation 19/01/22 - 23/02/22	We request that the assessment provides confirmation regarding the presence of pacific oysters on existing piles. Are these piles to be removed during the construction? How do you plan to manage this invasive species?	Pacific oysters are widespread on existing piles and other hard port structures in the region. No piles are proposed to be removed during construction. Biosecurity control measures have been detailed within the CEMP (Application Document Reference number 9.2) and ABP's existing biosecurity management procedures will be followed during operation.
Environment Agency	Statutory Consultation 19/01/22 - 23/02/22	Due to a current lack of specialist resource in respect of the noise impacts from percussive piling on migratory fish, we are currently deferring to the Marine Management Organisation and its specialist advisers in respect of this topic.	Noted.
Environment Agency	Pre-application meeting, 20 May 2022	The meeting provided an update of the IEERT project and also responses the Environment Agency made with respect to the physical processes and flood/coastal protection impact assessments. In addition, potential cumulative and in-combination effects of the proposed development with the Humber Stallingborough Phase 3 Flood Defence Project on ecological receptors was also discussed.	The Environment Agency has provided information on the project which has been used to inform the Cumulative and In-Combination assessments (Chapter 20).

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
DFDS (, PI 32	Statutory Consultation 19/01/22 - 23/02/22	The project would be built into the Humber Estuary Ramsar/SAC/SPA and will therefore almost certainly have an adverse effect on the integrity of the site. Chapter 4 of the PEIR does not adequately demonstrate need for the project, rather setting out predicted demand for ro-ro traffic without examining whether existing capacity could meet it. If the project is to go ahead in a Natura 2000 site, ABP must demonstrate there are imperative reasons of overriding public importance that it does so, and that compensatory land is provided. At present, none of these have been demonstrated to a satisfactory degree. In particular there are other installations on the Humber that could accommodate these works with less harm to the Natura 2000 site. The impact on air quality and noise from HGVs travelling on local roads, particularly Queens Road where a 274% increase is predicted, has not adequately been assessed, and although net gain is not a legal requirement for DCOs, it is still	The HRA (Application Document Reference number 9.6) has assessed the potential for an adverse effect on site integrity as a result of the proposed development. The loss of intertidal habitat as a result of the proposed development is considered *de minimis* in extent (following refinements to the scheme) and consequently is not considered to result in an adverse effect on site integrity. On this basis, compensatory habitat is not required. Air quality and noise impacts are assessed in Chapter 13 and Chapter 14 of the ES respectively. As per subsequent Natural England advice during statutory consultation (summarised in this table), the Defra metric (used to calculate net gain) should not be used to assess impacts and calculate compensation for habitat damage or loss in designated sites or irreplaceable habitat.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		recommended but does not seem to have been addressed.	
North Lincolnshire Council (P138)	Statutory Consultation 19/01/22 - 23/02/22	The Natural Environment Policy Specialist has advised that, in terms of landscape and terrestrial ecology, the proposal is not likely to have any significant effects of relevance to North Lincolnshire. Furthermore, the approach proposed for the EIA and the Habitat Regulations Assessment (HRA) is supported, as amended by the advice of Natural England. For the in-combination assessment within the HRA, it is advised that the applicant makes use of the Humber Partnership In-combination Database.	Humber Partnership In-combination Database has been used to inform the In-combination Assessment (Chapter 20).
North East Lincolnshire Council (NELC) (P145)	Statutory Consultation 19/01/22 - 23/02/22	The PEIR leads on from the EIA Scoping process that was undertaken for the development in late 2021. The scope of the EIA as agreed by PINS, in relation to Ecology, considered the relevant designations of the Humber Estuary and potential landside impacts. The NELC Ecologist supports the scope and extent of the PEIR and subsequent EIA.	Noted.
Q1	Statutory Consultation 19/01/22 - 23/02/22	Concern raised regarding the impact on the lugworm beds, which are used by local anglers, but which also feed birds and other wildlife	Potential impacts on mudflat habitats/species as well as coastal waterbirds have been considered in detail as part of the assessment.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
Lincolnshire Wildlife Trust (Q79)	Statutory Consultation 19/01/22 - 23/02/22	Looking forward to reviewing the Environmental Statement on behalf of the Lincolnshire Wildlife Trust.	Noted.
RSPB (Q80)	Statutory Consultation 19/01/22 - 23/02/22	Awaiting the Environmental Statement and information on mitigation and compensation in order to comment on the likely environmental effects.	Noted.
MMO (PI 10)	Supplementary Statutory Consultation – 28 Oct – 27 Nov 2022	The potential impacts on benthic ecology as listed in the PEIR are comprehensive and the baseline benthic ecological features have been adequately described based on a range of desk-based and targeted intertidal and subtidal surveys. Impacts which have been scoped out have been supported by sensitive justifications.	Noted.
MMO (PI 10)	Supplementary Statutory Consultation – 28 Oct – 27 Nov 2022	No information has been added [to the Supplementary Consultation Report] to address previous comments regarding the requirement for additional mitigation measures to reduce the impacts of underwater noise and vibration from percussive and vibro-piling on migratory fishes. The MMO do not anticipate that the reduction in the number of piles and reduced volumes for dredging will significantly alter the outcomes of the EIA project description to take account	Agreed. The reduction in the number of piles and reduced volumes for dredging has not altered the outcomes of the underwater noise assessment included in Appendix 9.2 to this ES.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		of the changes made to the project infrastructure.	
MMO (PI 10)	Supplementary Statutory Consultation – 28 Oct – 27 Nov 2022	Agreement on the proposed restrictions and what is acceptable in terms of percussive piling and vibro-piling per day during the sensitive seasons, if piling is permitted, need to be sought.	Agreed. ABP has had pre-application meetings with the MMO and Cefas to discuss the potential mitigation measures required for the underwater noise effects of piling on migratory fish (7 April 2022 and 3 October 2022). In addition, two technical notes (dated 21 April 2022 and 13 June 2022) and a pre-meeting briefing note (30 September 2022) have been issued to the MMO/Cefas to set out the available evidence and proposed package of mitigation measures.
MMO (PI 10)	Supplementary Statutory Consultation – 28 Oct – 27 Nov 2022	The assessment undertaken at the PEIR stage is sufficiently robust and proportionate to fully identify and assess the project's potential impacts on shellfish.	Noted.
MMO (PI 10)	Supplementary Statutory Consultation – 28 Oct – 27 Nov 2022	Given that the worst-case option for the provision of impact protection measures is an open piled structure, the MMO expect the effects of noise and vibration from piling operations to be included/considered.	An underwater noise assessment which assesses the effects from piling operations on marine fauna has been undertaken and is included in the underwater noise assessment (Appendix 9.2 to this ES).
MMO (PI 10)	Supplementary Statutory Consultation – 28 Oct – 27 Nov 2022	During the initial PEIR consultation in February 2022, a number of reservations were made regarding the underwater noise assessment, although it was acknowledged that the general conclusions of the assessment	The statutory comments that were received from the MMO on the PEIR have been discussed with the MMO in meetings (23 February 2022 and 7 April 2022) and taken on board in the ES and the underwater noise assessment (Appendix 9.2 to this ES). A

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		were reasonable. While the reservations should be noted for future assessments, the MMO consider that the ES should take note of these and should be updated accordingly to provide further clarification where required.	detailed response to each of the PEIR comments is provided above within this consultation table.
Natural England (PI 22)	Supplementary Statutory Consultation – 28 Oct – 27 Nov 2022	It is Natural England's advice that the proposal is not directly connected with or necessary for the management of the European site. You should therefore determine whether the proposal is likely to have a significant effect on any European site, proceeding to the Appropriate Assessment stage where significant effects cannot be ruled out.	It has been determined that the IERRT project is likely to have a significant effect on the Humber Estuary EMS, and an HRA has been undertaken. The HRA is submitted with the DCO application (Application Document Reference number 9.6).
Natural England (PI 22)	Supplementary Statutory Consultation – 28 Oct – 27 Nov 2022	Natural England advises that the HRA should consider the potential for likely significant effects as a result of loss and change in both intertidal and subtidal habitat. This should include loss of SAC habitat (i.e., Estuaries and Mudflats and sandflats not covered by seawater at low tide) as well as the loss of supporting habitat for SPA bird species. If it is considered necessary to include in the final application the additional impact protection measures, then this should also be included in the HRA.	The HRA (Application Document Reference number 9.6) has considered the potential for loss (both direct and indirect) and change to intertidal and subtidal habitats and has been assessed in the context of SAC features ('Estuaries' and 'Mudflats and sandflats not covered by seawater at low tide') as well as the loss of supporting habitat for SPA bird species. This ES chapter and the HRA consider the impact of the additional impact protection measures.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
Natural England (PI 22)	Supplementary Statutory Consultation – 28 Oct – 27 Nov 2022	Natural England considers that any credible risk of a measurable loss of marine or terrestrial habitat, no matter how small, from within a European site is a 'likely significant effect' and the full significance of its impact on site integrity should be screened-in and further tested by an Appropriate Assessment. It is Natural England's advice that a lasting and irreparable loss of European Site habitat will prevent a conclusion of no adverse effect on site integrity being reached unless an Appropriate Assessment can clearly ascertain otherwise.	All predicted loss (both direct and indirect) and change to intertidal and subtidal habitats has been screened into the Appropriate Assessment stage in the HRA (Application Document Reference number 9.6).
Natural England (PI 22)	Supplementary Statutory Consultation – 28 Oct – 27 Nov 2022	Natural England advises that further assessment is required within an Appropriate Assessment, and we will give our statutory advice at that stage.	Noted.
Natural England (PI 22)	Supplementary Statutory Consultation – 28 Oct – 27 Nov 2022	The appropriate assessment should be made in view of the European sites' conservation objectives, which provides a list of attributes contributing to site integrity that can provide a checklist for the assessment process, the detailed supplementary advice and advice on operations should also inform the conclusion.	The Appropriate Assessment has been made in in view of the European sites' conservation objectives and also has been informed by the supplementary advice and advice on operations.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
Natural England (PI 22)	Supplementary Statutory Consultation – 28 Oct – 27 Nov 2022	Plans or projects that should be considered in the in-combination assessment include the following: The incomplete or non-implemented parts of plans or projects that have already commenced; Plans or projects given consent or given effect but not yet started; Plans or projects currently subject to an application for consent or proposed to be given effect; Projects that are the subject of an outstanding appeal; Ongoing plans or projects that are the subject of regular review; Any draft plans being prepared by any public body; Any proposed plans or projects published for consultation prior to application. Chapter 20 of the PIER provides a list of projects that would be included in an assessment of the potential in-combination effects, if deemed necessary. Natural England broadly agrees with the selection criterion. When assessing the effects on designated sites, Natural England recommends that the search radius be measured from the nearest point on	The specified types of projects are considered in the cumulative and in-combination effects assessment. Immingham Green Energy Terminal has been included in the list of projects to assess. The assessment is provided in Chapter 20 of this ES and in the HRA (Application Document reference number 9.6).

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		the designated site to the proposal being assessed, or the nearest area of sensitive habitat, if known. This would likely identify those proposals which are likely to affect overlapping geographic extents within the designated site in question. Natural England notes that the Immingham Green Energy Terminal has not been included in table 20.4 in the PEIR.	
Natural England (PI 22)	Supplementary Statutory Consultation – 28 Oct – 27 Nov 2022	Our advice regarding the potential impacts upon the Humber Estuary SSSI coincides with our advice regarding potential impacts upon the Humber Estuary SAC/SPA/Ramsar as detailed above.	Noted.
DFDS (PI 15)	Supplementary Statutory Consultation – 28 Oct – 27 Nov 2022	The supplementary consultation refers to two new ecological enhancements, one to the east of the port at Long Wood and one on the north bank of the Humber at Skeffling. It is not clear whether these are to compensate for harm to protected habitats or to provide Biodiversity Net Gain ("BNG"), or both. If the former, it should be demonstrated that the birds using the habitat that is being lost will be able to use the new habitat and it is a like-for-like replacement. If the latter, the	The DFDS response refers to the delivery of the ecological enhancements. The ecological improvements do not constitute compensation, neither do they constitute formal BNG provision in the way in which the DFDS suggests. As the DFDS response make clear, the Environment Act requirement for the provision of BNG is not yet a statutory requirement. The ecological enhancements are, therefore, being provided to meet wider policy provisions.

Consultee	Reference, Date	Summary of Response	How Comments have been Addressed In this Chapter
		requirement for NSIPs as set out in the Environment Act 2021, is that the habitat will have to have been provided since 30 January 2020 to count, and so long-standing habitat banking would not (although it is not yet a statutory requirement to provide BNG). It is also not clear what the value of the enhancement to Long Wood would be and how many biodiversity units would be lost and gained – this should be set out in the Environmental Statement.	Further information is provided in the Woodland Enhancement Management Plan (WEMP) (Application Document Reference number 9.4) and Chapter 2, Section 2.3.

9.5 Implications of policy legislation and guidance

9.5.1 This section of the chapter sets out key aspects and implications of policy and guidance that are relevant to the assessment of likely impacts on marine ecology receptors. It builds upon the overarching chapter covering Legislation, Policy and Consenting Framework (Chapter 5).

Legislation

The Habitats Regulations

9.5.2 The Habitats Directive (92/43/EEC) is intended to help maintain biodiversity throughout the EU Member States by defining a common framework for the conservation of wild plants, animals and habitats of community interest. It established a network of Special Areas of Conservation (SAC) designated by Member States to conserve habitats and species (listed in Annexes I and II).

9.5.3 Directive 2009/147/EC on the conservation of wild birds is known as the 'Birds Directive'. It creates a comprehensive scheme of protection for all wild bird species. The Directive recognises that habitat loss and degradation are the most serious threats to the conservation of wild birds. It, therefore, places great emphasis on the protection of habitats for endangered as well as migratory species (listed in Annex I), especially through the establishment of a coherent network of Special Protection Areas (SPAs) comprising all the most suitable territories for these species.

9.5.4 The Habitats Directive and Birds Directive are implemented in England and Wales through the Conservation of Habitats and Species Regulations 2017 as amended, known as the "Habitats Regulations"[3].

9.5.5 The Habitats Regulations provide for the designation and protection of 'European sites', the protection of 'European protected species' and the adaptation of planning and other controls for the protection of European Sites. The Regulations also require the compilation and maintenance of a register of European sites, to include SACs (classified under the Habitats Directive) and SPAs (classified under the Birds Directive). These sites form the Natura 2000 network. These regulations also apply to Ramsar sites (designated under the 1971 Ramsar Convention for their internationally important wetlands), candidate SACs (cSAC), potential Special Protection Areas (pSPA), and proposed and existing European offshore marine sites.

9.5.6 Where a development project is located close to, or within, a European/Ramsar Site, the Habitats Regulations apply. This requires the Competent Authority to determine whether the proposed development has

[3] Following the UK leaving the EU, the Conservation of Habitats and Species Regulations 2017 have been modified by the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019. Available at: https://www.legislation.gov.uk/uksi/2019/579/contents/made (accessed October 2021).

the potential for a likely significant effect (LSE) on the interest features and/or supporting habitat of a European/Ramsar site either alone or in-combination with other plans, projects and activities and, if so, to undertake an Appropriate Assessment (AA) of the implications of the proposals in light of the site's conservation objectives.

9.5.7 The entire Humber Estuary is designated as a SAC and a SPA under the Habitats and Birds Directives. It is also classified as a 'Ramsar site' under the Ramsar Convention due to the presence of internationally important wetlands. These designations form the Humber Estuary European Marine Site (EMS). Given that the proposed development falls within these designated sites, ABP is of the view that the project will trigger the requirement for a HRA to assess the implications of the proposals.

9.5.8 Information to support the Competent Authority's assessment of the proposed development against the requirements of the Habitats Regulations has been provided in the HRA with the DCO application (Application Document Reference number 9.6). This draws on information included within the Nature Conservation and Marine Ecology chapter and other chapters within the ES.

The Water Framework Regulations

9.5.9 The Water Framework Directive (2000/60/EEC) (WFD) establishes a framework for the management and protection of Europe's water resources. It is implemented in England and Wales through the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 as amended, known as the Water Framework Regulations[4].

9.5.10 The overall objectives of the WFD, as implemented by the Water Framework Regulations, is to achieve "*good ecological and good chemical status*" in all inland and coastal waters by 2021 unless alternative objectives are set or there are grounds for time limited derogation. For example, where pressures preclude the achievement of good status (e.g. navigation, coastal defence) in heavily modified water bodies (HMWBs), the WFD provides that an alternative objective of "*good ecological potential*" is set.

9.5.11 The proposed development (and associated disposal sites) is located within the Humber Lower water body (ID: GB530402609201).

9.5.12 A WFD compliance assessment has been prepared to support the DCO application. This assesses the potential impacts of the proposed development on biological, chemical and physical elements of the relevant WFD water bodies to determine whether the proposed development complies with the objectives of the WFD. The assessment includes consideration of the potential risks for several key biological receptors, specifically habitats, fish, protected areas and invasive non-native species (INNS). The WFD compliance assessment is included in an appendix to the

[4] Following the UK leaving the EU, the main provisions of the WFD have been retained in English law through The Floods and Water (Amendment etc.) (EU Exit) Regulations 2019.

ES (Appendix 8.1) and draws on information provided both in this Nature Conservation and Marine Ecology chapter and other chapters within the ES.

The Marine and Coastal Access Act 2009 (MCAA)

9.5.13 The MCAA provides the legal mechanism to help ensure clean, healthy, safe, productive and biologically diverse oceans and seas by putting in place a new system for improved management and protection of the marine and coastal environment.

9.5.14 With respect to MCZs, the Holderness Inshore MCZ is the nearest MCZ to the IERRT (located approximately 20 km away). This is considered to be beyond the zone of potential effects of the proposed development and as a consequence, a MCZ Assessment is not considered to be required.

The Wildlife and Countryside Act 1981 (WCA)

9.5.15 The WCA is the principal mechanism for the legislative protection of wildlife in Great Britain.

9.5.16 The WCA is the means by which the Convention on the Conservation of European Wildlife and Natural Habitats (the Berne Convention), the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), the Birds Directive (79/409/EEC) and the Natural Habitats and Wild Fauna and Flora Directive (92/43/EEC) are implemented in Great Britain.

9.5.17 The WCA applies to the terrestrial environment and inshore waters (0 to 12 nautical miles) and concerns the protection of wild animals and the designation of protected areas, including SSSIs.

The Countryside and Rights of Way Act 2000 (CRoW Act)

9.5.18 The CRoW applies to England and Wales only. Part III of the CRoW Act deals specifically with wildlife protection and nature conservation.

9.5.19 The CRoW Act places a duty on Government Departments to have regard for the conservation of biodiversity and maintain lists of species and habitats for which conservation steps should be taken or promoted, in accordance with the Convention on Biological Diversity. Schedule 9 of the CRoW Act amends the SSSI provisions of the WCA, including increased powers for the protection and management of SSSIs. The provisions extend powers for entering into management agreements; place a duty on public bodies to further the conservation and enhancement of SSSIs; increase penalties on conviction where the provisions are breached; and include an offence whereby third parties can be convicted for damaging SSSIs.

Natural Environment and Rural Communities Act 2006 (NERC Act)

9.5.20 The NERC Act came into force in October 2006. In addition to establishing Natural England as the body responsible for conserving, enhancing, and

managing England's natural environment, the Act also made amendments to the both the Wildlife and Countryside Act 1981 and the CRoW Act 2000. For example, it extended the CRoW biodiversity duty to public bodies and statutory undertakers and altered enforcement powers in connection with wildlife prosecution. In addition to this, the NERC Act contains a number of additional measures designed to help streamline delivery and simplify the legislative framework, such as changes to the remit and constitution of the Joint Nature Conservation Committee (JNCC), reconstitution of the Inland Waterways Amenity Advisory Council, and improving the governance arrangements for the National Parks.

9.5.21 Section 41 (S41) of the NERC Act requires the Secretary of State to publish a list of habitats and species which are of principal importance for the conservation of biodiversity in England. The list has been drawn up in consultation with Natural England, as required by the NERC Act.

9.5.22 Under the biodiversity duty, which is part of the NERC Act, public authorities must show regard for conserving biodiversity in all their actions. Consequently, regard must be had to priority species and habitats that are of principle importance for the purpose of conserving biodiversity and that may be adversely affected during the construction and operation of the proposed development.

The Eels (England and Wales) Regulations (2009)

9.5.23 The Eels (England and Wales) Regulations 2009 implement Council Regulation (EC) No 1100/2007 of the Council of the European Union, establishing measures for the recovery of the stock of European eel. This includes the requirement to notify the Environment Agency of the construction, alteration or maintenance of any structure likely to affect the passage of eels and where any such structure exists, the requirement to construct and operate an eel pass to allow the free passage of eels.

Conservation of Seals Act 1970 (CoSA)

9.5.24 Seals are a protected animal under CoSA. The Act does not prohibit the killing of seals, but it does regulate the way in which they are killed. There is an annual closed season in this respect for grey seals (*Halichoerus grypus*) which extends from 1 September to 31 December. There is also an annual closed season for common seals (*Phoca vitulina*) which runs from 1 June to 31 August.

National Policy

National Policy Statement for Ports

9.5.25 The National Policy Statement for Ports (2012) (NPSfP) provides the framework for decisions on proposals for new harbour facility developments that constitute a Nationally Significant Infrastructure Project. This policy requires that in order to meet the requirements of the Government's policies on sustainable development, new port infrastructure should also, amongst

other things, preserve, protect and where possible improve marine and terrestrial biodiversity, be adapted to the impacts of climate change and provide high standards of protection for the natural environment.

9.5.26 As highlighted in paragraphs 5.1.8 and 5.1.9 of the NPSfP, developments should aim to avoid significant harm to biodiversity and geological conservation interests, including through mitigation and consideration of reasonable alternatives. They should also ensure that appropriate weight is attached to designated sites of international, national and local importance.

9.5.27 As highlighted in paragraphs 5.1.4 and 5.1.5 of the NPSfP, where the development is subject to EIA, the applicant should ensure that the ES clearly sets out any effects on internationally, nationally and locally designated sites of ecological or geological conservation importance, on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity. The applicant should provide environmental information proportionate to the infrastructure where EIA is not required to help the decision-maker consider thoroughly the potential effects of a proposed project. The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests.

UK Marine Policy Statement (MPS)

9.5.28 The Marine Policy Statement (2011) (MPS) is the framework for preparing marine plans and taking decisions affecting the marine environment. The MPS also sets out the general environmental, social and economic considerations that need to be taken into account in marine planning and provides guidance on the pressures and impacts that decision makers need to consider when planning for and permitting development in the UK marine areas. Paragraphs 3.1.7 and 3.1.8 of the MPS are relevant to the marine ecology assessment of the proposed development which, amongst other things, state that:

> *"Marine plan authorities and decision makers should take account of how developments will impact on the aim to halt biodiversity loss and the legal obligations relating to all MPAs, their conservation objectives, and their management arrangements..."*

9.5.29 Marine plan authorities and decision-makers should take account of the regime for MPAs and comply with obligations imposed in respect of them. This includes the obligation to ensure that the exercise of certain functions contribute to, or at least do not hinder, the achievement of the objectives of an MCZ. This would also include the obligations in relevant legislation relating to SSSIs and sites designated under the Birds and Habitats Directives.

East Inshore and East Offshore Marine Plans

9.5.30 The East Inshore and East Offshore Marine Plans (2014), which are collectively referred to as 'the East Marine Plans', were formally adopted on

2 April 2014. The East Inshore Marine Plan area covers 6,000 km² of sea, from mean high water springs (MHWS) out to the 12 nautical mile limit from Flamborough Head in the north to Felixstowe in the south. The East Offshore Marine Plan covers 49,000 km² of area from the 12 nautical mile limit to the border with The Netherlands, Belgium and France.

9.5.31 There are six policies within the East Marine Plans specifically related to nature conservation and marine ecology:

- Policy ECO1 - Cumulative impacts affecting the ecosystem of the East marine plans and adjacent areas (marine, terrestrial) should be addressed in decision-making and plan implementation: Information on the cumulative and in-combination effects assessment for the proposed development are included in Chapter 20 of the ES;

- Policy BIO1 - Appropriate weight should be attached to biodiversity, reflecting the need to protect biodiversity as a whole, taking account of the best available evidence on those habitats and species that are protected or of conservation concern in the East Marine Plans and adjacent areas (marine, terrestrial):
  - Further details on potential nature conservation and marine ecology effects of the proposed development are included in Section 9.8 of this chapter;

- Policy MPA1 - Any impacts on the overall MPA network must be taken into account in strategic level measures and assessments, with due regard given to any current agreed advice on an ecologically coherent network:
  - Further information is provided in an HRA which is included in the DCO application. In addition, there is considered to be no significant risk that the proposed development will affect any MCZ interest features, given the nearest MCZ is the Holderness Inshore MCZ which is located over 20 km away from the proposed development;

- S-NIS-1 - Proposals must include any appropriate measures to avoid or minimise significant adverse impacts on the marine area that could arise through the introduction and transport of non-indigenous species, particularly when: 1) moving equipment, boats or livestock (for example fish and shellfish) from one water body to another 2) introducing structures suitable for settlement of non-indigenous species, or the spread of invasive non-indigenous species known to exist in the area:
  - ABP currently manage INNS in accordance with specific procedures to ensure ABP reduces the risk of introduction and/or spread of INNS where possible. Further details are provided in Section 9.9 of this chapter; and

- S-UWN-2 - Proposals that generate impulsive sound and/or ambient noise must demonstrate that they will, in order of preference: a) avoid, b) minimise, c) mitigate significant adverse impacts on highly mobile species, d) if it is not possible to mitigate significant adverse impacts, proposals must state the case for proceeding.
  - Further details are provided in Section 9.9 of this chapter.

Local Policy

North East Lincolnshire Local Plan 2013 to 2032

9.5.32 The North East Lincolnshire Local Plan was adopted in 2018 and covers the period 2013 to 2032. Policy 7 of the plan highlights that for operational port areas "*proposals for port related use will be* supported *and, where appropriate, approved by the Council if the submitted scheme accords with the development plan as a whole and subject to the ability to satisfy the requirements of the Habitats Regulations*."

9.5.33 In addition, Policy 41 of the plan states that:

"The Council will have regard to biodiversity and geodiversity when considering development proposals, seeking specifically to:

A. establish and secure appropriate management of long-term mitigation areas within the Estuary Employment Zone, managed specifically to protect the integrity of the internationally important biodiversity sites (see Policy 9 'Habitat Mitigation - South Humber Bank');

B. designate Local Wildlife Sites (LWSs) and Local Geological Sites (LGSs) in recognition of particular wildlife and geological value;

C. protect manage and enhance international, national and local sites of biological and geological conservation importance, having regard to the hierarchy of designated sites, and the need for appropriate buffer zones;

D. minimise the loss of biodiversity features, or where loss is unavoidable and justified ensure appropriate mitigation and compensation measures are provided;

E. create opportunities to retain, protect, restore and enhance features of biodiversity value, including priority habitats and species; and,

F. take opportunities to retain, protect and restore the connectivity between components of the Borough's ecological network.

Any development which would, either individually or cumulatively, result in significant harm to biodiversity which cannot be avoided, adequately mitigated or as a last resort compensated for, will be refused".

9.6 Description of the existing environment

Nature conservation sites and protected species

Designated sites

9.6.1 The proposed development falls within the boundaries of the Humber Estuary SAC, SPA and Ramsar site (collectively forming the Humber EMS; Figure 9.3). For the Humber Estuary SAC, the primary reason for

designation is the presence of two broad scale habitats, 1130 Estuaries and 1140 Mudflats and sandflats not covered by seawater at low tide (JNCC, 2022a). These broad scale habitats support other more specific habitats which are qualifying features but not a primary reason for designation. These are:

- 1110 Sandbanks which are slightly covered by sea water all the time;
- 1150 Coastal lagoons (identified as a priority feature);
- 1310 *Salicornia* and other annuals colonizing mud and sand;
- 1330 Atlantic salt meadows (Glauco-Puccinellietalia maritimae);
- 2110 Embryonic shifting dunes;
- 2120 Shifting dunes along the shoreline with *Ammophila arenaria* ('white dunes');
- 2130 Fixed coastal dunes with herbaceous vegetation ('grey dunes') (identified as a priority feature); and
- 2160 Dunes with Hippopha rhamnoides.

9.6.2 Alongside the habitats for which the SAC is designated, there are also three mobile species listed on Annex II of the EU Habitats Directive (92/43/EEC) (the Natural Habitats and Wild Fauna and Flora Directive) included in the designation (JNCC, 2022a), namely:

- 1095 Sea lamprey *Petromyzon marinus*;
- 1099 River lamprey *Lampetra fluviatilis*; and
- 1364 Grey seal Halichoerus grypus.

9.6.3 Qualifying features of the Humber Estuary SPA and Humber Estuary Ramsar site are shown in Table 9.8 and Table 9.9 respectively.

Table 9.8. Qualifying features of the Humber Estuary SPA

Internationally Important Populations of Regularly Occurring Annex 1 Species	
Breeding Species Population	
Bittern *Botaurus stellaris*	2 calling males (10.5% of the GB population)
Marsh Harrier *Circus aeruginosus*	10 breeding females (6.3% of the GB population)
Avocet *Recurvirostra avosetta*	64 pairs (8.6% of the GB population)
Little Tern *Sternula albifrons*	51 pairs (2.1% of the GB population)
Wintering Species Population	
Bittern	4 (4.0% of the GB population)
Hen harrier *Circus cyaneus*	8 (1.1% of the GB population)
Bar-tailed Godwit *Limosa lapponica*	2,752 (4.4% of the GB population)
Golden Plover *Pluvialis apricaria*	30,709 (12.3% of the GB population)
Avocet *Recurvirostra avosetta*	54 (1.7% of the GB population)
On passage Species population	
Ruff *Calidris pugnax*	128 (1.4% of the GB population)

Internationally Important Populations of Regularly Occurring Migratory Species	
Wintering Species Population	
Teal† *Anas crecca*	2,322 (<1% of the population)
Wigeon† *Mareca penelope*	5,044 (<1% of the population)
Mallard† *Anas platyrhynchos*	2,456 (<1% of the population)
Turnstone† *Arenaria interpres*	629 (<1% of the population)
Common Pochard† *Aythya ferina*	719 (<1% of the population)
Greater Scaup† *Aythya marila*	127 (<1% of the population)
Brent Goose† *Branta bernicla*	2,098 (<1% of the population)
Goldeneye† *Bucephala clangula*	467 (<1% of the population)
Sanderling† *Calidris alba*	486 (<1% of the population)
Dunlin *Calidris alpina*	22,222 (1.7% of the Northern Siberia/Europe/Western Africa population)
Red Knot *Calidris canutus*	28,165 (6.3% of the North-eastern Canada/Greenland/Iceland/North-western Europe population)
Ringed Plover† *Charadrius hiaticula*	403 (<1% of the population)
Oystercatcher† *Haematopus ostralegus*	3503 (<1% of the population)
Black-tailed Godwit *Limosa*	1,113 (3.2% of the Icelandic Breeding population)
Curlew† *Numenius arquata*	3,253 (<1% of the population)
Grey Plover† *Pluvialis squatarola*	1,704 (<1% of the population)
Shelduck *Tadorna tadorna*	4,464 (1.5% of the North-western Europe population)
Redshank *Tringa totanus*	4,632 (3.6% of the Eastern Atlantic Wintering population)
Northern Lapwing† *Vanellus vanellus*	22,765 (<1% of population)
On passage Species Population	
Sanderling†	818 (<1% of the population)
Dunlin	20,269 (1.5% of the Northern Siberia/Europe/Western Africa population)
Red Knot	18,500 (4.1% of the North-eastern Canada/Greenland/Iceland/North-western Europe population)
Ringed Plover†	1,766 (<1% of the population)
Black-tailed Godwit	915 (2.6% of the Icelandic Breeding population)
Whimbrel† *Numenius phaeopus*	113 (<1% of the population
Grey Plover†	1,590 (<1% of the population)
Greenshank† *Tringa nebularia*	77 (<1% of the population)
Redshank	7,462 (5.7% of the Eastern Atlantic Wintering population)
Internationally Important Assemblage of Waterfowl	
Waterfowl assemblage	153,934 waterfowl
†Species with this symbol do not represent a population that is > 1% of the international threshold but are included in the waterfowl assemblage.	

Source: JNCC (2022b)

Table 9.9. Qualifying marine features of the Humber Estuary Ramsar Site

Ramsar Criterion	
Criterion 1 – natural wetland habitats that are of international importance	
The site is a representative example of a near-natural estuary with the following component habitats: dune systems and humid dune slacks, estuarine waters, intertidal mud and sand flats, saltmarshes, and coastal brackish/saline lagoons.	
Criterion 3 – supports populations of plants and/or animal species of international importance	
The Humber Estuary Ramsar site supports a breeding colony of grey seals *Halichoerus grypus* at Donna Nook. It is the second largest grey seal colony in England and the furthest south regular breeding site on the east coast.	
Criterion 5 – Bird Assemblages of International Importance	
Wintering waterfowl	153,934 waterfowl (5-year peak mean 1998/99-2002/3)
Criterion 6 – Bird Species/Populations Occurring at Levels of International Importance	
Species	Spring/Autumn Population (5-year peak mean 1996-2000)
Golden Plover	17,996 (2.2% of the Iceland & Faroes/East Atlantic population)
Red Knot	18,500 (4.1% of the West & Southern African wintering population)
Dunlin	20,269 (1.5% of the West Siberia/West Europe population)
Black-tailed Godwit	915 (2.6% of the Iceland/West Europe population)
Redshank	7,462 (5.7% of the population)
Species	Wintering Population (5-year peak mean 1996/7-2000/1)
Shelduck	4,464 (1.5% of the North-western Europe Population)
Golden Plover	30,709 (3.8% of the Iceland & Faroes/East Atlantic population)
Red Knot	28,165 (4.1% of the West & Southern African wintering population)
Dunlin	22,222 (1.7% of the West Siberia/West Europe population)
Black-tailed Godwit	1,113 (3.2% of the Iceland/West Europe population)
Bar-tailed Godwit	2,752 (2.3% of the West Paleartic population)
Criterion 8 – Internationally important source of food for fishes, spawning grounds, nursery and/or migration path	
The Humber Estuary acts as an important migration route for both river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus* between coastal waters and their spawning areas.	

Source: JNCC (2022c)

9.6.4 The Greater Wash SPA is designated for a range of seabird and diving bird species and is located approximately 20 km from the proposed development. Qualifying features of this site is shown in Table 9.10

Table 9.10. Qualifying marine features of the Greater Wash SPA

Internationally Important Populations of Regularly Occurring Annex 1 Species	
Breeding Species Population	
Little Tern *Sternula albifrons*	798 pairs (42% of GB breeding population)
Common Tern *Sterna hirundo*	510 pairs (5.1% of GB breeding population)
Sandwich Tern *Sterna sandvicensis*	852 pairs (35% of GB breeding population)
Wintering Species Population	
Little Gull *Hydrocoloeus minutus*	1,255 (no current GB population estimate)
Red-throated Diver *Gavia stellata*	1,407 (8.3% of GB non-breeding population)
Internationally Important Populations of Regularly Occurring Migratory Species	
Common Scoter *Melanitta nigra*	3,449 (0.6% of biogeographic population)

Source: JNCC (2022d)

9.6.5 The Humber Estuary Site of Special Scientific Interest (SSSI) overlaps part of the project site. This is designated for its nationally important habitat assemblage (intertidal mudflats and sandflats, and coastal saltmarsh) geological interest, importance to breeding, wintering and passage birds, breeding grey seal and the presence of river and sea lamprey.

9.6.6 North Killingholme Haven Pits SSSI is located approximately 5 km away from the proposed development. This site comprises saline lagoon habitats and supports important populations of waders including Black-tailed Godwits and Redshank. The Lagoons SSSI is located approximately 20 km from the proposed development and supports a variety of coastal habitats (such as saline lagoons and sand dunes) and well as a population of breeding Little Terns.

9.6.7 The Holderness Inshore MCZ is the nearest MCZ to the project site (located approximately 20 km away). The site is designated for intertidal sand and muddy sand as well as a variety of subtidal rock and sedimentary habitats.

9.6.8 The nearest Local Nature Reserve (LNR) is Cleethorpes Sands LNR (located approximately 13 km south east of the proposed development) which supports a variety of intertidal and coastal habitats.

Protected species

9.6.9 The Wildlife and Countryside Act 1981 (as amended) (WCA) protects various animals, plants, habitats in the UK. Relevant protected WCA species recorded in the Humber Estuary region include:

- The tentacled lagoon worm *Alkmaria romijni;*
- The lagoon sand shrimp *Gammarus insensibilis*;
- Twaite shad *Alosa fallax* and allis shad *Alosa alosa*;
- Cetacean (whale and dolphin) species; and
- All bird species.

9.6.10 Marine species are also protected from being killed, injured or disturbed both inside and outside designated sites under the provisions of the Habitats Directive. Of relevance to the Humber Estuary are:

- Common seal *Phoca vitulina* and grey seal *Halichoerus grypus* (listed in Annex II and V);
- Bottlenose dolphin *Tursiops truncatus* and harbour porpoise *Phocoena phocoena* (listed in Annex II and IV);
- Sea lamprey *Petromyzon marinus* (listed in Annex II) and river lamprey (listed in Annex II and V);
- Twaite shad *A. fallax* and allis shad *A. alosa* (listed in Annex II and V); and
- Atlantic salmon *Salmo salar* (listed in Annex II and V).

9.6.11 Seals are also protected under the Conservation of Seals Act 1970.

9.6.12 All naturally occurring wild bird species, their eggs, nests and habitats are strictly protected under the Habitats Regulations.

9.6.13 In addition, some marine fauna and habitats are listed as priority species and habitats of principle importance in England, as required under Section 41 of the NERC Act. Species of principal importance which are of relevance to the Humber Estuary include various species of waterbird, commercial fish (such as cod *Gadus morhua* and herring *Clupea harengus*), migratory fish (such as lampreys, European smelt *Osmerus eperlanus*, Atlantic salmon *Salmo salar* and European eel *Anguilla anguilla*).

9.6.14 Habitats of principle importance which are of relevance to the Humber Estuary include intertidal mudflats, coastal saltmarsh, saline lagoons and sand dunes. Based on the current geographic extent and location of habitats of principal importance under Section 41 of the Natural Environment and Rural Communities Act 2006 that are publicly available on the MAGIC website (Natural England, 2022), the proximity of these coastal and intertidal habitats to the IERRT project are described below:

- Mudflats: The intertidal habitat directly overlaps the footprint of the IERRT project;
- Coastal saltmarsh: The nearest saltmarsh habitat is located approximately 3 km to the northwest of the IERRT project;
- Coastal sand dunes: The nearest coastal sand dunes within the Humber SAC are located more than 12 km southwest of the IERRT project at Cleethorpes; and
- Saline lagoons: The nearest coastal lagoon habitat within the Humber Estuary is located approximately 5 km from the IERRT project at Killingholme.

9.6.15 European eels are also afforded protection as part of the Eels (England and Wales) Regulations 2009. The regulations which apply to all freshwater and estuarine waters of England and Wales give powers to statutory bodies to implement measures for the recovery of European eel stocks including improving access, habitat quality and easing fishing pressure.

Benthic habitats and species

Humber Estuary overview

9.6.16 The Humber Estuary supports a wide variety of marine habitats including intertidal mudflats and sandflats, intertidal seagrass beds, coastal lagoons, saltmarsh, reedbeds, subtidal sandbanks and mixed sediment habitats (Humber Nature Partnership, 2015; Natural England, 2015; Franco *et al*., 2015).

9.6.17 The intertidal area of the Humber Estuary is extensive, covering approximately 10,000 ha, of which more than 90% is mudflat and sandflat (English Nature, 2003). The largest areas of mudflat occur in the outer Humber Estuary at Spurn Bight and Pyewipe, at Foul Holme and Skitter Sand in the mid Humber Estuary and across most of the Estuary width in the inner estuary above the Humber Bridge. This habitat changes from moderately exposed sandy shores at the mouth of the Humber Estuary to sheltered muddy shores within the main body of the Estuary and up into the tidal rivers. The mid and upper Humber Estuary is characterised by fringing reedbeds *Phragmites australis* on the upper shore while saltmarshes are present along the north bank and on the Lincolnshire coast east of Cleethorpes (English Nature, 2003; Natural England, 2021a; Natural England 2021b; Franco *et al*., 2015).

9.6.18 The subtidal area of the Estuary is approximately 16,800 ha in extent (English Nature, 2003). The subtidal environment of the Humber Estuary is highly dynamic and varies according to the composition of the bottom sediments, salinity, sediment load and turbidity and dissolved oxygen. Many of these factors vary with the season or state of the tide. Subtidal sand (including muddy sand) is the predominant subtidal sediment type in the Humber Estuary. The high mobility of sediments and high turbidity means that this habitat is typically relatively impoverished with a limited fauna characterised by very low densities of opportunistic species and species adapted to these conditions (Natural England, 2021a; Natural England 2021b; English Nature, 2003).

9.6.19 Invasive marine species known to occur in the Humber Estuary region include slipper limpet *Crepidula fornicata*, Chinese mitten crab *Eriocheir sinensis*, Pacific oyster *Magallana gigas* and acorn barnacle *Austrominius modestus* (Natural England, 2015; IECS, 2010; Appendix 9.1).

Project specific benthic surveys

9.6.20 In order to characterise the benthic communities present in the vicinity of the proposed development (and associated dredge disposal sites), intertidal and

subtidal sampling was undertaken in September 2021. The intertidal samples were collected using a 0.01 m² hand-held core and the subtidal stations using a 0.1 m² Day Grab from the following areas:

- **Immingham Eastern Ro-Ro Terminal intertidal samples**: Ten stations within and near to the proposed development footprint (Figure 9.2);
- **Immingham Eastern Ro-Ro Terminal subtidal samples**: Ten stations within and near to the proposed development footprint (Figure 9.2);
- **HU056 disposal site subtidal samples:** Six stations (four within each of the disposal sites and two nearby to each of the disposal sites) (Figure 9.2); and
- **HU060 disposal site subtidal samples:** Six stations (four within each of the disposal sites and two nearby to each of the disposal sites (Figure 9.2).

9.6.21 At each station, a sample was analysed for macrofaunal analysis (faunal composition, abundance and biomass), PSA and TOC. Polychaetes, bivalves and other species considered to be waterbird prey items were also measured and categorised using size classes.

9.6.22 The results of these project specific benthic surveys are summarised below and in Table 9.11 to 9.13 with the methods and results described in more detail in Appendix 9.1 of this ES.

Immingham Eastern Ro-Ro Terminal intertidal samples

9.6.23 The sediment in samples collected in this area consisted predominantly of sandy mud (Table 9.11). The TOC in the samples ranged between approximately 1% and 3%. Overall, the number of taxa found in the samples was variable and ranged from four (Station IMM 1 and IMM 3) to 15 (Station IMM 7). The number of individuals was also highly variable and ranged from 1,100 organisms per m² (Station IMM 1) to 40,600 organisms per m² (Station IMM 7). The range in total species biomass in the samples was between 1 gram per m² at Station IMM 3 and 190 grams per m² at Station IMM 7 (which was primarily attributed to the ragworm *Hediste diversicolor* and the peppery furrow shell *Scrobicularia plana*) (Table 9.11 of this chapter).

9.6.24 The infaunal samples were predominantly characterised by nematodes, the oligochaetes *Tubificoides benedii* and *Enchytraeida*e spp., the mud shrimp *Corophium volutator*, the mudsnail *Peringia ulvae*, Baltic tellin *Limecola balthica* as well as the polychaetes *Hediste diversicolor* and *Pygospio elegans*. These characterising species dominated the assemblage and contributed almost entirely to the total abundances of organisms recorded at most of the sites. All the species recorded from the samples in this area were considered commonly occurring in the region and not protected (Table 9.11 of this chapter).

9.6.25 During the surveys, the non-native Pacific oyster *Crassostrea gigas* and barnacles were recorded attached to piles on existing jetties in the area.

9.6.26 The assemblage recorded is considered typical of the community recorded on mudflats in the nearby area (ABPmer, 2009; IECS, 2010; Able UK Limited, 2021). For example, intertidal surveys at North Killingholme (located approximately 3 km from the proposed development) in 2015 and 2016 also recorded a benthic assemblage characterised by species such as *Corophium volutator, Tubificoides benedii, Pygospio elegans, Hediste diversicolor, Limicola balthica* and nematodes with a broadly similar total number of individuals in the samples (up to around 50,000 organisms per m²) (Able UK Limited, 2021).

9.6.27 Many of the species recorded in the samples are considered prey species for coastal waterbirds such as polychaetes, Baltic tellin *Limecola balthica*, mudsnail *Peringia* spp. and mudshrimp *Corophium* spp. (Stillman *et al.,* 2005; Woodward *et al*., 2014). The species and size of the prey taken varies between different coastal waterbirds. Larger waders are typically capable of consuming larger invertebrate prey items than smaller species. For example, Dunlin typically takes polychaetes up to 50 to 60 mm and the bivalve *Limecola balthica* up to 8 mm whereas larger waders such as Curlew, godwits and Oystercatcher will consume polychaetes up to 80 mm and *Limecola balthica* up to 20 mm. In addition, only smaller species of wader typically consume *Peringia* spp. and *Corophium* spp. such as Dunlin, Ringed Plover and Common Redshank (Stillman *et al.,* 2005). In order to better understand prey size in the samples collected, prey species were assigned to different size classes based on a size class classification supplied by the laboratory which has been used by Natural England and the Environment Agency in previous studies. The results are summarised in Table 9.12. The benthic prey recorded in the surveys were typically small size classes that are consumed by both smaller and larger wading bird species.

Table 9.11. Intertidal benthic survey results

Station	Sediment Type	TOC (%)	No. of Taxa (per m²)	No. of Individuals (per m²)	Total Biomass (g per m²)	Key Characterising Species (Number per m² shown in brackets)
IMM 1	Mud	3.65	4	1,100	6.29	*Nematoda* (400) *Limecola balthica* (300) *Tubificoides benedii* (300) *Nephtys* (100)
IMM 2	Sandy Mud	3.32	14	15,400	105.76	*Peringia ulvae* (4,600) *Nematoda* (2,400) *Enchytraeidae* (2,100) *Hediste diversicolor* (1,500) *Tubificoides benedii* (1,400) *Pygospio elegans* (1,100) *Abra tenuis* (500)
IMM 3	Sandy Mud	2.99	4	1,300	1.13	*Nematoda* (500) *Limecola balthica* (500) *Tubificoides benedii* (200) *Tharyx (100)*
IMM 4	Sandy Mud	2.92	9	20,700	31.14	*Tubificoides benedii* (14,400) *Corophium volutator* (3,600) *Nematoda* (800) *Limecola balthica* (700) *Tellinoidea* (600) *Pygospio elegans* (300)
IMM 5	Sandy Mud	3.05	6	1,600	6.16	*Tubificoides benedii* (900) *Limecola balthica* (300) *Nematoda* (100) *Enchytraeidae* (100) *Corophium volutator* (100) *Tellinoidea* (100)

Station	Sediment Type	TOC (%)	No. of Taxa (per m²)	No. of Individuals (per m²)	Total Biomass (g per m²)	Key Characterising Species (Number per m² shown in brackets)
IMM 6	Sandy Mud	2.90	11	30,300	58.07	*Enchytraeidae* (5,400) *Peringia ulvae* (5,400) *Tubificoides benedii* (5,000) *Nematoda* (4,900) *Hediste diversicolor* (2,700) *Limecola balthica* (2,500) *Abra tenuis* (2,000)
IMM 7	Sandy Mud	3.36	15	40,600	189.77	*Tubificoides benedii* (13,800) *Enchytraeidae* (5,700) *Nematoda* (5,100) *Limecola balthica* (3,500) *Pygospio elegans* (3,400) *Hediste diversicolor* (3,300) *Peringia ulvae* (1,800)
IMM 8	Sandy Mud	3.05	14	4,100	15.87	*Nematoda* (800) *Limecola balthica* (700) *Tubificoides benedii* (600) *Peringia ulvae* (400) *Hediste diversicolor* (300)
IMM 9	Sandy Mud	3.73	14	21,600	47.98	*Hediste diversicolor* (6,800) *Nematoda* (3,200) *Abra tenuis* (2,000) *Enchytraeidae* (1,600) *Peringia ulvae* (1,500) *Tubificoides benedii* (1,400) *Limecola balthica* (1,200)

Station	Sediment Type	TOC (%)	No. of Taxa (per m²)	No. of Individuals (per m²)	Total Biomass (g per m²)	Key Characterising Species (Number per m² shown in brackets)
IMM 10	Sandy Mud	2.71	8	26,800	57.37	*Corophium volutator* (16,400) *Tubificoides benedii* (4,800) *Nematoda* (2,100) *Limecola balthica* (1,800) *Tellinoidea* (1,100) *Eteone longa* (400)

Table 9.12. Size classes of key bird prey species

Species group	Species	Size class	Abundance (total for all intertidal samples)	Biomass (total for all intertidal samples)	% (proportion of the total recorded within a particular size class for each species)
Polychaetes	*Eteone longa*	<25 mm	14	0.005	100
		>25 mm	0	0	0
	Hediste diversicolor	<25 mm	113	0.2202	77
		25-50 mm	34	1.2453	23
	Nephtys spp	<25 mm	3	0.0068	100
		>25 mm	0	0	0
	Pygospio elegans	<25 mm	68	0.0142	100
		>25 mm	0	0	0
	Streblospio shrubsolii	<25 mm	12	0.0015	100
		>25 mm	0	0	0
	Tharyx	<25 mm	3	0.0003	100
		>25 mm	0	0	0
	Manayunkia aestuarina	<25 mm	22	0.0003	100
		>25 mm	0	0	0

Species group	Species	Size class	Abundance (total for all intertidal samples)	Biomass (total for all intertidal samples)	% (proportion of the total recorded within a particular size class for each species)
Crustacean	*Corophium volutator*	<3 mm	142	0.0285	65
		>3 mm	75	0.0597	35
Gastropod	*Peringia ulvae*	<3 mm	136	0.0986	99
		3-5 mm	1	0.005	1
Bivalves	*Limecola balthica*	<9 mm	117	0.8544	98
		9-15 mm	2	0.4533	2
	Abra tenuis	<5 mm	51	0.2517	100
		>5 mm	0	0	0
	Scrobicularia plana	20-25 mm	2	1.6589	100
Size classes used: *Hediste diversicolor* + other polychaetes: <25 mm, 25-50 mm, 50-75 mm, 75-100 mm, >100 mm *Corophium volutator* + other corophiid species: <3 mm, >3 mm *Peringia ulvae*:<3 mm, 3-5 mm, >5 mm *Macoma balthica:*<9 mm, 9-15 mm, 15-20 mm, >20 mm Other bivalve species: < 5 mm, 5-10 mm, 10-15 mm, 15-20 mm					

Immingham Eastern Ro-Ro Terminal subtidal samples

9.6.28 The sediment from samples collected from the area of the proposed development consisted of mud and sandy mud. The TOC in the samples ranged between approximately 3% and 13% (Table 9.13 of this chapter). Overall, the number of taxa found in the samples ranged from two (Station IMM 15) to 17 (Station IMM 14), and the number of individuals from 20 organisms per m² (Station IMM 15) to 37,540 organisms per m² (Station IMM 13). However, most stations were relatively impoverished (<10 taxa and <10,000 organisms per m²). The range in total species biomass in the samples was between <1 and 14 grams per m².

9.6.29 The faunal samples were predominantly characterised by nematodes, the mudsnail *Corophium volutator*, polychaetes (such as *Streblospio shrubsolii Polydora cornuta Tharyx* spp. and *Nephtys* spp.), oligochaetes *Tubificoides* spp. and barnacle *Amphibalanus improvises*. All the species recorded from the samples in this area were considered commonly occurring in the region and not protected.

9.6.30 The faunal assemblage recorded is considered characteristic of subtidal habitats in this section of the Humber Estuary. For example, subtidal benthic surveys undertaken in the Immingham area in 2009, 2010 and 2016 predominantly recorded mud or muddy sand habitat which was generally impoverished (with a low number of taxa occurring at the majority of sites). The most commonly recorded infaunal species (generally recorded in low abundances) were the polychaetes *Capitella capitata*, *Streblospio shrubsolii, Pygospio elegans, Polydora cornuta*, oligochaetes *Tubificoides* spp., mud shrimp *Corophium volutator*, and nematodes (ABPmer, 2009; IECS, 2010; Able UK Limited, 2021).

HU056 disposal site subtidal samples

9.6.31 The sediment in samples collected in this area consisted of sand, gravelly sand and sandy gravel with TOC ranging from between approximately 1% and 3% (Table 9.13). The stations were considered highly impoverished (with 0 to 2 taxa and 0 to 30 organisms per m² recorded). The samples were characterised by low abundances of a few species (the amphipod *Corophium volutator*, mysid shrimp *Gastrosaccus spinifer*, bryozoan *Electra monostachys* and springtails *Collembola* spp.).

9.6.32 Benthic monitoring in 2017 at disposal site HU056 recorded commonly occurring estuarine species generally in low abundances such as the polychaetes *Polydora cornuta, Pygospio elegans Arenicola marina* and *Capitella* spp., bivalve *Limecola balthica*, mysid shrimps and amphipods (ABPmer, 2017).

9.6.33 The impoverished assemblage recorded is considered typical of scoured subtidal habitats in the Humber Estuary (which are subject to very strong tidal currents). No protected species were recorded.

HU060 disposal site subtidal samples

9.6.34 The sediment in samples collected in this area consisted predominately of sand with TOC between approximately<1 and 3% at all stations (Table 9.13 of this chapter).

9.6.35 Most stations were considered impoverished (<7 taxa and <121 organisms per m²). However, 16 taxa were recorded at both Station HU060 4 and HU060 6 with 1,880 and 4,030 organisms per m² respectively at each of these stations. Biomass ranged from 0 to 3.37 grams per m².

9.6.36 The samples were characterised by a wide range of species but typically in low abundances including nematodes, barnacle *Amphibalanus improvises*, polychaetes (such as *Pygospio elegans* and *Arenicola* spp.) and the amphipod *Corophium volutator*. All the species recorded from the samples in this area were considered commonly occurring in the region and not protected.

9.6.37 Benthic surveys undertaken in 2008 within and near to Clay Huts disposal sites also recorded a community characterised by the polychaetes *Arenicola marina* and *Pygospio elegans* as well as nematodes and amphipods (ABPmer, 2009).

Table 9.13. Subtidal benthic survey results

Area	Station	Sediment Type	TOC (%)	No. of Taxa (per m²)	No. of Individuals (per m²)	Total Biomass (g per m²)	Key Characterising Species (Number per m² shown in brackets)
Immingham Eastern Ro-Ro Terminal	IMM 11	Mud	3.83	12	11,740	8.32	*Corophium volutator* (8, 910) *Tubificoides benedii* (1,570) *Streblospio shrubsolii* (420) *Nematoda* (250) *Tharyx* (240) *Limecola balthica* (130) *Tubificoides swirencoides* (100)
	IMM 12	Sandy Mud	4.63	16	12,270	1.44	*Nematoda* (9,830) *Streblospio shrubsolii* (1,210) *Amphibalanus improvises* (450) *Polydora cornuta* (440) *Corophium volutator* (110) *Mytilus edulis* (90) *Tharyx* (60)
	IMM 13	Sandy Mud	13.01	4	37,540	14.13	*Corophium volutator* (33,130) *Polydora cornuta* (4,170) *Nematoda* (230) *Tubificoides benedii* (10)

Area	Station	Sediment Type	TOC (%)	No. of Taxa (per m²)	No. of Individuals (per m²)	Total Biomass (g per m²)	Key Characterising Species (Number per m² shown in brackets)
	IMM 14	Sandy Mud	4.03	17	22,480	3.34	*Streblospio shrubsolii* (13,790) *Nematoda* (7,150) *Amphibalanus improvisus* (520) *Polydora cornuta* (340) *Tharyx* (210) *Tubificoides benedii* (210) *Corophium volutator* (70)
	IMM 15	Sandy Mud	13.01	2	20	0.10	*Nephtys hombergii* (10) *Amphibalanus improvisus* (10)
	IMM 16	Sandy Mud	4.03	5	250	1.19	*Tubificoides benedii* (120) *Nephtys* (50) *Nematoda* (40) *Limecola balthica* (40)
	IMM 17	Sandy Mud	3.98	4	80	0.09	*Nephtys* (30) *Nematoda* (20) *Diastylis rathkei* (20) *Corophium volutator* (10)
	IMM 18	Sandy Mud	3.69	5	9,580	6.30	*Corophium volutator* (9,550) *Tubificoides benedii* (10) *Enchytraeidae* (10) *Limecola balthica* (10)
	IMM 19	Mud	4.23	8	300	0.57	*Streblospio shrubsolii* (110) *Nematoda* (50) *Nephtys hombergii* (50) *Tubificoides benedii* (30) *Tharyx* (20) *Limecola balthica* (20) *Diastylis rathkei* (10)

Area	Station	Sediment Type	TOC (%)	No. of Taxa (per m²)	No. of Individuals (per m²)	Total Biomass (g per m²)	Key Characterising Species (Number per m² shown in brackets)
	IMM 20	Sand	4.22	9	5,130	4.91	*Corophium volutator* (4,950) *Streblospio shrubsolii* (70) *Nematoda* (30) *Nephtys* (30) *Limecola balthica* (20) *Diastylis rathkei* (10) *Austrominius modestus* (10) *Tubificoides benedii* (10)
Disposal site HU060	HU060 1	Sand	4.04	6	40	0.004	*Nematoda* (10) *Pygospio elegans* (10) *Arenicola* (10) *Bathyporeia elegans* (10)
	HU060 2	Sand	0.38	0	0	0.00	
	HU060 3	Slightly Gravelly Muddy Sand	0.92	6	60	0.01	*Scoloplos armiger* (20) *Eteone longa* (10) *Tharyx* (10) *Corophium volutator* (10) *Tellinoidea* (10)
	HU060 4	Sand	1.69	16	1,880	3.37	*Amphibalanus improvisus* (1,800) *Nototropis guttatus* (20) *Jaera (Jaera) albifrons* (20) *Scoloplos armiger* (10) *Tubificoides benedii* (10) *Corophium volutator* (10) *Limecola balthica* (10)
	HU060 5	Sand	2.51	3	120	0.01	*Protodriloides chaetifer* (90) *Mytilus edulis* (20) *Tubificoides benedii* (10)

Area	Station	Sediment Type	TOC (%)	No. of Taxa (per m²)	No. of Individuals (per m²)	Total Biomass (g per m²)	Key Characterising Species (Number per m² shown in brackets)
	HU060 6	Sand	3.04	16	4,030	0.56	*Nematoda* (2,170) *Pygospio elegans* (900) *Arenicola* (590) *Polydora cornuta* (80) *Ampharete cf. acutifrons* (80) *Austrominius modestus* (50) *Corophium volutator* (50)
Disposal site HU056	HU056 1	Sand	2.01	1	30	0.001	*Corophium volutator* (30)
	HU056 2	Slightly Gravelly Muddy Sand	2.84	2	0	0.001	*Corophium volutator* (P) *Electra monostachys* (P)
	HU056 3	Muddy Gravel	1.05	1	10	0.002	*Corophium volutator* (10)
	HU056 4	Gravelly Mud	1.01	0	0	0.00	
	HU056 5	Gravelly Sand	1.40	0	0	0.00	
	HU056 6	Muddy Gravel	1.03	2	20	0.12	*Gastrosaccus spinifer* (10) *Collembola* (10)

Fish

Humber Estuary overview

9.6.38 The Humber Estuary contains a varied fish fauna, totalling over 80 species with the majority common to most UK estuaries. The Humber Estuary fish assemblage comprises resident, nursery, seasonal and migratory species, typical of estuarine fish communities (Environment Agency, 2013; Elliot and Marshall, 2000).

9.6.39 In general, the abundance and diversity of fish increases towards the mouth of the estuary. The outer reaches are characterised by a community dominated by inshore marine species such as whiting *Merlangius merlangus*, cod *Gadus morhua*, plaice *Pleuronectes platessa* and Dover sole *Solea solea*. The middle and upper reaches of the estuary support more euryhaline species including flounder *Platichthys flesus*, European eel *Anguilla anguilla*, gobies and sprat *Spratus spratus* (Marshall and Elliot, 1997; Elliott and Marshall, 2000).

9.6.40 The Humber Estuary supports a fish assemblage typical of other estuaries in North Western Europe. However, a higher fish diversity than recorded in other estuaries in the UK has been found which may be due to the large catchment area and high fluvial flow allowing freshwater taxa to actively or passively occur in greater numbers into this estuary (Waugh *et al.*, 2019).

9.6.41 The baseline review presented in this chapter has primarily focused on key species which are of either commercial and/ or conservation importance. The functional guilds for estuarine fish used in Environment Agency (2013) which were based on published guild definitions (Elliott *et al*., 2007; Franco *et al.,* 2008) have been used to help summarise the life history and ecology of fish species occurring in the Humber Estuary, as follows:

- Diadromous species (D): Species using estuaries as pathways of migration (for reproduction) between fresh waters and the sea; migration from fresh water to sea water to breed (catadromous species, e.g. eel), and in the opposite direction (anadromous species, e.g., salmonids and lampreys);

- Marine migrant species (MM): Marine species that spawn at sea and regularly enter estuaries in large numbers, thus having a temporary residence in the estuarine habitat; they usually are highly euryhaline species, able to move throughout the full length of the estuary, and spending much of their life within estuaries, using these habitats as nursery grounds or visiting them regularly at sub-adult and adult life stages;

- Estuarine resident species (ES): Species that are able to reproduce and complete their life cycle in the estuary; as such they are highly euryhaline species, able to move throughout the full length of the estuary;

- Marine straggler species (MS); Marine species usually associated with coastal marine waters but entering estuaries accidentally in low numbers. These are predominantly stenohaline species, occurring most frequently in the lower sections of the estuary; and

- Freshwater species (F): Species of freshwater origin that regularly or accidentally enter estuaries, in moderate to low numbers, moving varying distances down the estuary but often restricted to low-salinity, upper reaches of estuaries and to periods of freshwater flooding.

9.6.42 Table 9.14 provides a summary of species that have been recorded in the Humber Estuary (based on the Environment Agency, 2013) with further information on key species within each ecological guild provided below.

Table 9.14. Fish recorded in the Humber Estuary, grouped by ecological guilds.

Ecological guild	Species name	Common name	Ecological guild	Species name	Common name
Diadromous (D)	*Alosa alosa*	Allis shad	Marine stragglers (MS)	*Hyperoplus immaculatus*	Greater sandeel
	Alosa fallax	Twaite shad		*Hyperoplus lanceolatus*	Great sandeel
	Osmerus eperlanus	Smelt		*Callionymus lyra*	Dragonet
	Lampetra fluviatilis	River lamprey		*Taurulus bubalis*	Long-spined sea scorpion
	Petromyzon marinus	Sea lamprey		*Pollachius virens*	Coley / Saithe / Coalfish
	Salmo salar	Atlantic salmon		*Trisopterus minutus*	Poor cod
	Salmo trutta	Brown / sea trout		*Melanogrammus aeglefinus*	Haddock
	Gasterosteus aculeatus	3-spined stickleback		*Crystallogobius linearis*	Crystal goby
	Liza ramada	Thinlip mullet		*Pomatoschistus lozanoi*	Lozano's goby
	Anguilla	European eel		*Liparis montagui*	Montagu's seasnail
Marine migrants (MM)	*Atherina presbyter*	Sand smelt		*Gaidropsarus mediterraneus*	Shore rockling
	Clupea harengus	Atlantic herring		*Mullus surmuletus*	Striped red mullet
	Sprattus	Sprat		*Glyptocephalus cynoglossus*	Witch flounder
	Cyclopterus lumpus	Lumpsucker		*Microstomus kitt*	Lemon Sole
	Gadus morhua	Atlantic cod		*Scomber scombrus*	Mackerel
	Merlangius merlangus	Whiting		*Scophthalmus rhombus*	Brill
	Pollachius	Pollack		*Scyliorhinus sp.*	Spotted dogfish
	Trisopterus luscus	Pouting / Bib		*Buglossidium luteum*	Solenette
	Ciliata mustela	5-bearded rockling		*Entelurus aequoreus*	Snake pipefish
	Dicentrarchus labrax	Sea bass		*Echiichthys vipera*	Lesser weever

Ecological guild	Species name	Common name	Ecological guild	Species name	Common name
	Chelon labrosus	Thick lipped grey mullet		*Chelidonichthys cuculus*	Red gurnard
	Liza aurata	Golden grey and	Fresh-water species (F)	*Cobitis taenia*	Spined loach
	Limanda	Dab		*Abramis brama*	Common bream
	Platichthys flesus	Flounder		*Alburnus alburnus*	Common bleak
	Pleuronectes platessa	Plaice		*Blicca bjoerkna*	Silver bream
	Scophthalmus maximus	Turbot		*Carassius auratus*	Goldfish
	Solea solea	Dover sole		*Rutilus rutilus*	Roach
	Chelidonichthys lucernus	Tub gurnard		*Scardinius erythrophthalmus*	Rudd
	Eutrigla gurnardus	Grey gurnard		*Squalius cephalus*	Chub
Estuarine residents (ES)	*Agonus cataphractus*	Hooknose / Pogge		*Tinca tinca*	Tench
	Ammodytes tobianus	Lesser sandeel		*Gobio gobio*	Gudgeon
	Myoxocephalus scorpius	Shorthorn sculpin		*Leuciscus cephalus*	Chub
	Raniceps raninus	Tadpole-fish		*Leuciscus*	Dace
	Aphia minuta	Transparent goby		*Rutilus x Alburnus alburnus*	Roach x Common bleak hybrid
	Pomatoschistus microps	Common goby		*Scardinius erythrophthalmus x Abramis brama*	Rudd x Common bream hybrid
	Pomatoschistus minutus	Sand goby		*Esox lucius*	Pike
	Liparis	Sea-snail		*Pungitius pungitius*	10-spined stickleback
	Pholis gunnellus	Rock gunnel		*Perca fluviatilis*	Perch
	Syngnathus acus	Greater pipefish		*Gymnocephalus cernuus*	Ruffe

Ecological guild	Species name	Common name	Ecological guild	Species name	Common name
	Syngnathus rostellatus	Lesser (Nillsons) pipefish			
	Zoarces viviparus	Viviparous blenny			

Source: Environment Agency, 2013.

Marine migrant species

9.6.43 With respect to demersal fish considered to be marine migrant species, the Humber Estuary is considered to be an important nursery ground for several commercially important gadoids including whiting *Merlangius merlangus* and cod *Gadus morhua* (Figure 9.4). These species are typically the most abundant gadoids occurring in the Humber Estuary (Ellis *et al*., 2012; Environment Agency, 2013). Further information on the ecology of these species is provided in Table 9.15. Other gadoids commonly occurring include pouting *Trisopterus luscus* and pollack *Pollachius pollachius*.

9.6.44 A range of flatfish species are commonly recorded in the Humber Estuary region with flounder *Platichthys flesus* considered to be the most commonly occurring species. Nursery grounds for the commercially important Dover *sole Solea solea* and plaice *Pleuronectes platessa* occur in the region with these species also commonly occurring. Spawning grounds for Dover sole also occur in the region (Table 9.15 and Figure 9.4 of this chapter). In addition, dab *Limanda limanda* and turbot *Scophthalmus maximus* are also recorded.

9.6.45 With respect to pelagic marine migrant species (free-swimming fish that inhabit the mid-water column), the clupeids sprat *Sprattus sprattus* and herring *Clupea harengus* are the most commonly occurring species. The Humber Estuary is considered to be nursery ground for herring (Figure 9.4 to this chapter). These pelagic species tend to have little association with the seabed and as a result are often distributed over widespread and indistinct grounds, often forming large shoals. Sea bass *Dicentrarchus labrax* is also frequently recorded in the Humber Estuary. Further information on the ecology of these species is provided in Table 9.15.

Table 9.15. Background information on the most commonly recorded marine migrant species occurring in the Humber Estuary.

Species	Ecology
Whiting	In the Humber Estuary, whiting is recorded throughout most of the year with the highest abundances typically occurring in autumn. Most individuals recorded are juveniles, suggesting the Humber Estuary is predominantly used as a nursery ground.
Cod	In the Humber Estuary, the species occurs throughout most of the year but at lower frequency in the spring and summer. Cod is rarely recorded in intertidal and shallow subtidal habitats within the Humber Estuary. Most individuals recorded are juveniles, suggesting the Humber Estuary is predominantly used as a nursery ground. Spawning occurs offshore between January and April, peaking during February, with spawning grounds in the North Sea usually located in the pelagic zone at depths between 20 m and 100 m.
Flounder	Flounder occurs year-round in the Humber Estuary but with higher abundance typically recorded in late spring and summer. This species occurs in inshore waters to depths of 50 m and commonly reported

Species	Ecology
	using estuarine systems as nurseries. In the North Sea, the species generally spawn in spring in deeper marine waters, and larvae and early juveniles use selective tidal transport to migrate upstream to estuaries and rivers hence it may be regarded as semi-catadromous.
Dover sole	In the Humber Estuary, sole is recorded throughout most of the year with juvenile sole generally appearing in the Humber Estuary during the late spring and summer, after larvae and juveniles are transported here from adjacent coastal spawning areas by tidal currents. In the North Sea, the species generally reproduces in spring (March to late June, with a peak in April) in coastal waters, with spawning areas along the East coast of England from the Humber Estuary down to the Norfolk coast. In the North Sea, the nurseries are in shallow (< a few metres deep) sandy or muddy bottoms.
Plaice	Plaice occur throughout most of the year in the Humber Estuary with juveniles mainly recorded, suggesting the Humber Estuary is predominantly used as a nursery ground. Plaice spawn between January and April (with peak densities on spawning grounds in May). Spawning grounds in the UK are generally located at between 20 m and 40 m water depth with spawning grounds for plaice occurring in the marine areas near the mouth of the Humber Estuary. Plaice is a marine flatfish that uses estuarine habitats as nursery grounds. Plaice live mostly on sandy bottoms, although it can also be found on gravel and mud and on sandy patches in rocky areas, habitats and coastal zones as nursery grounds.
Dab	Dab occurring in the Humber Estuary are mainly juveniles, which suggests the estuary is predominantly as a nursery ground. Dab spawn from January to June in the North Sea) with adults migrating to deeper waters between May and September.
Herring and sprat	Both sprat and herring occur in the Humber Estuary throughout most of the year but with a lower frequency in the spring and higher frequency in autumn (herring) and winter (sprat). Most individuals of both species recorded are juveniles or young individuals. Sprat is very abundant in the shallow coastal and estuarine areas of the North Sea in winter before spawning offshore between May and August in the North Sea. Herring spawn in shoals on coarse sand, gravel, shells and small stones in shallow water between 15 to 40 m depth. Herring are demersal spawners, depositing their sticky eggs on coarse sand, gravel, small stones and rock. Young herring spend some time in the inshore areas before migrating offshore to join the adult population. Stocks that spawn in spring tend to use inshore spawning grounds whilst autumn and winter spawners tend to move offshore using the edges of ocean banks (e.g., around the Dogger Bank and off the Northumberland and Yorkshire coasts).

Species	Ecology
Sea bass	The occurrence of the sea bass in the Humber Estuary is typically sporadic. Data suggests that the estuary is predominantly used by juvenile/young stages, although the typically low frequency and abundance of the species suggest that the Humber Estuary is not an important nursery ground for sea bass.

Sources: Environment Agency, 2013; MALSF, 2011; Ellis *et al*., 2012, Hessen *et al*., 2015.

Estuarine resident fishes

9.6.46 The sand goby *Pomatoschistus minutus* is the most frequently recorded goby species in the Humber Estuary, with common goby *P. microps* and the transparent goby *Aphia minuta* also occurring.

9.6.47 Sand gobies are frequently encountered in all areas of the estuary, but mainly in shallow intertidal areas in sandy and muddy habitats. Spawning occurs in shallow waters over an extended period, mostly during the spring and summer (sand goby spawn in summer while common goby spawn after their first winter between February and September, depending on the latitude), with multiple batches of eggs laid during this season (batch spawner).

9.6.48 Other estuarine resident species occurring in the Humber Estuary include lesser sandeel *Ammodytes tobianus*, hooknose *Agonus cataprachus*, tadpole fish *Raniceps raninus*, sea snail *Liparis liparis*, rock gunnel *Pholis gunnellus,* pipefish (greater pipefish *Sygnathus acus* and lesser pipefish *S. rostellatus*), and the viviparous blenny *Zoarces viviparus*.

Marine stragglers and freshwater species

9.6.49 Marine stragglers occur relatively infrequently with species recorded including the lesser weever *Echiichthys vipera* and dragonet *Callionymus lyra*.

9.6.50 The most commonly recorded freshwater species recorded in the Humber Estuary are roach *Rutilus rutilus* and common bream *Abramis brama* with other freshwater species recorded including and silver bream *Blicca bjoerkna* and rudd *Scardinius erythrophthalmus.* These species are typically recorded in the upper and mid sections of the Humber Estuary.

Diadromous migratory fish

9.6.51 Diadromous migratory fish (species migrating between freshwater and seawater) which occur in the Humber Estuary include salmonids (Atlantic salmon *Salmo salar* and sea trout *Salmo trutta*), lampreys (river lamprey *Lampretra fluviatilis* and sea lamprey *Petromyzon marinus*), European eel *Anguilla anguilla*, shads (allis shad *Alosa alosa* and twaite shad *Alosa fallax*) and European smelt *Osmerus eperlanus*. Of these species, European eel, European smelt and river lamprey have been the species most commonly recorded in sampling in the Humber Estuary (Environment Agency, 2013). These species are all afforded protection under various legislation as described above.

9.6.52 Further information on the ecology and migration of these species is provided in Table 9.16.

Table 9.16. Background information on the ecology and distribution of diadromous migratory fish

Species	Ecology
European eel	European eel is catadromous species which migrates to the marine environment (Sargasso Sea) to spawn. The larvae (leptocephali) then drift in the Gulf Stream and then North Atlantic Drift current for 2 to 3 years across the Atlantic Ocean to Europe and metamorphose into juveniles (glass eels/elvers). The eels usually migrate into fresh water where they remain for many years. However, not all eels migrate into fresh water and some, predominantly males, remain in inshore coastal areas. The adults, commonly referred to as 'silver eels' during the spawning migration, leave river systems to return to the Sargasso Sea. The European Eel is widely distributed in the Humber catchment, although it is absent from the upper reaches of some rivers. In the Humber catchment, glass eels/elvers generally immigrate in spring and early summer, whereas the majority of silver eel emigrate in late summer and autumn. Eels are typically present in the Humber Estuary in the spring and summer. There is evidence that glass eels migrate upstream using 'Selective Tidal Stream Transport' (STST) whereby individuals with low locomotive capability, such as glass eels, move into the water column during flood tides to move up estuaries toward freshwater, typically remaining on or in the bottom substrate on ebb tides to avoid currents. Glass eel behaviour can be influenced by light levels, and although glass eels do migrate during the day there is an increase in activity during the night time, particularly in the first hours of darkness, when they also distribute closer to the surface. Some research suggests an increased abundance in glass eel catches during the new moon phase, but not the full moon, despite the fact that the tidal amplitude during both periods is similar. This could potentially be explained by the influence of light intensity on migration patterns. This effect of the lunar cycle and hence moonlight intensity is modulated by cloud cover and turbidity; therefore, one consequence is the fact that any lunar effect is not usually observed in highly turbid estuaries (Harrison *et al.,* 2014).
European smelt	The European smelt is a small anadromous species, widely distributed throughout the Atlantic and European waters, that migrates from estuaries and coastal waters into the lower reaches of rivers to spawn in early spring. Data suggests that the highest densities of smelt in the Humber Estuary occur in

Species	Ecology
	the spring and summer. The spawning migration starts in September to October, when mature fishes aggregate in estuaries to overwinter. Upriver migration starts in March to April when temperatures rise above 4 to 6°C and during rainy and stormy weather. Adult smelt generally enter the tidal Trent and Ouse from the Humber Estuary in early March and presumably return to the estuary after spawning.
River and sea lamprey	The river lamprey and the sea lamprey are both anadromous species, spawning in freshwater but completing part of their lifecycle in estuaries or at sea. The sea lamprey adult growth phase is short and lasts around two years. In this time, the species is parasitic, feeding on a variety of marine and anadromous fishes, including shad and salmon as well as herring, cod, haddock and basking sharks. Unlike sea lamprey, the growth phase of river lamprey is primarily restricted to estuaries. River lamprey have been frequently recorded in the Humber Estuary, with the Ouse catchment believed to support one of the most important river lamprey populations in the UK. In the Humber basin, river lamprey mainly enter the rivers from the estuary in autumn and then spawn in April. Sea lamprey spawning is almost entirely restricted to the Ouse catchment, principally the Rivers Ouse, Swale, Ure and Wharfe. The spawning migration of sea lamprey usually takes place in April and May when the adults start to migrate back into fresh water. The upstream migration of river lamprey takes place almost exclusively at night, with adults being sedentary and resting under rocks and riverbanks during the day.
Shads	The twaite and allis shad are anadromous species. Mature allis shad, having spent most of their lives in the sea stop feeding and move into the estuaries of large rivers, migrating into fresh water during late spring (April to June). Adult twaite shad stop feeding at sea and gather in the estuaries of suitable rivers in early summer (April and May), moving upstream to spawn from mid-May to mid-July. Within the Humber Estuary, most records of allis shad were juveniles while twaite shad adults.
Atlantic salmon and sea trout	Atlantic salmon and sea trout are anadromous species which migrate to freshwaters to spawn, whilst spending much of their life in the marine environment. They spawn in upper reaches of rivers, where they live for one to three years before migrating to sea as smolts. Atlantic salmon and sea trout smolts move out of the rivers and migrate downstream to the sea in spring, with the main movements occurring between April and June. At sea, salmon grow rapidly and after one to three years return to their natal river to spawn. The majority of adult salmon return to their natal rivers in autumn, although a small proportion returns in the spring and summer. In the Humbler catchment, Atlantic salmon has been mainly recorded from the upper reaches of the Ouse with brown/sea trout widespread in

Species	Ecology
	the upper reaches of the Humber catchment. In the Humber Estuary, most Atlantic salmon and sea trout have been recorded in the spring months between April and June and have been of smolt size.

Sources: Environment Agency, 2013; Maitland and Hatton-Ellis, 2003 Maitland, 2003; Harrison *et al*., 2014.

9.6.53 In summary, existing data suggests that the Humber Estuary supports a wide range of fish species including commonly occurring estuarine species and migratory species including diadromous fish. The Humber Estuary is also considered an important nursery ground for a range of commercially important fish species.

Immingham area

9.6.54 Fish data collected as part of intertidal fyke net and subtidal beam trawl surveys undertaken in May/June 2010 at sites located approximately 3 to 4 km from the proposed development (between the Humber Sea Terminal and the Port of Immingham) has also been reviewed (IECS, 2010)[5]. Further information on these surveys is provided in Section 9.3 of this chapter.

9.6.55 The intertidal sampling (fyke netting) catch was dominated by flatfish species (flounder and sole) which consisted of 1+group flounder (born the year before) and mostly 0+ group sole, which suggested the area is used as a flatfish nursery. Single individuals of pollock, five-bearded rockling *Ciliata Mustela* and sand goby were also recorded (due to the small size of sand goby, this fish is normally misrepresented in fyke net catches).

9.6.56 Sand gobies and sole were the most abundant species recorded in the subtidal sampling (beam trawls) with other species recorded in lower abundances including whiting, five-bearded rockling and river lamprey. Sole caught in the subtidal survey were significantly larger than the specimens from the fyke nets. This is consistent with earlier research by Cefas that analysed annual 2 m beam trawl and 1.5 m push net survey data from the period 1981 to 1995 and found that 0-group sole were highest in the 2 to 5.9 m depth band (Rogers *et al.,* 1998).

9.6.57 The results of the most recently available Environment Agency TraC fish monitoring for the sites nearest the proposed development (seine netting/beam trawls at Foulholme Sands and otter trawls at Burcom) are summarised below. Beach seine netting targets both demersal and pelagic species occurring in shallow inshore locations. Beam and otter trawls target demersal species[6]. The Foulholme Sands surveys were undertaken twice a year in the spring and autumn with the Burcom surveys annually in the early

[5] A fyke net is a type of fish trap. It consists of long cylindrical netting bag usually with several netting cones fitted inside the netting cylinder to make entry easy and exit difficult. This fishing methods typically target demersal fish species.

[6] These bottom trawls would only accidentally capture pelagic species (such as sprat or sea bass).

winter. These monitoring sites are located approximately 4 km from the proposed development and are shown in Figure 9.5 to this chapter. Data was available up to 2017 for Foulholme Sands and up to 2019 for Burcom (Environment Agency, 2021).

Table 9.17. The total number of fish caught in fish surveys undertaken at Burcom and Foulhome Sands between 2013 and 2019

Species	Burcom Otter Trawl*	Foulhome Sands Beam Trawl**	Foulhome Sands Seine Net***
3-spined stickleback		1	41
5-bearded rockling	7		1
Bullrout / Short-spined sea scorpion	6		
Cod	150		
Common goby	7		8
Dab	48		
Dover sole	515	38	125
Dragonet		1	
Flounder	81	48	63
Herring	14	4	205
Hooknose / Pogge	7	4	
Lesser (Nillsons) pipefish		53	222
Lesser sandeel		1	
Lesser weever			1
Plaice	4	114	1303
River lamprey	1		
Sand goby	1220	21	752
Sea bass		1	35
Sea-snail	21		
Smelt	3		74
Sprat	9		20
Thin lipped grey mullet			9
Thornback ray / Roker	2		
Turbot			4
Viviparous blenny	1		6
Whiting	164	10	45
* Surveys undertaken between 2013 and 2019. ** Surveys undertaken between 2014 and 2017. *** Surveys undertaken between 2013 and 2017.			

9.6.58 In summary, the most abundant species recorded in the surveys summarised in Table 9.17 were sand gobies, the flatfish species plaice and Dover sole, the pelagic species herring and the gadoids whiting and cod.

Other commonly occurring species recorded included the diadromous European smelt, flounder, 3-spined stickleback, dab and sprat. The results are consistent with data for the wider Humber Estuary region (described above) which suggests that these species are some of the most commonly occurring species in the region. In addition, of note was a single individual River lamprey recorded in the Burcom Otter Trawl.

9.6.59 While these surveys do not overlap specifically with the proposed development, they are considered broadly representative of the fish assemblage that could be present within the dredge footprint and surrounding local area. This is because the surveys have used a variety of techniques to target different habitats within both the intertidal and subtidal. The TrAC surveys are also relatively contemporary and cover a range of seasons.

Marine mammals

Humber Estuary overview

Seals

9.6.60 The most commonly occurring marine mammals recorded in the Humber Estuary region are seals with populations of both grey seal *Halichoerus grypus* and common (harbour) seal *Phoca vitulina* occurring. Further information about the abundance and distribution of these species is provided below followed by a description of cetacean (whale, dolphin and porpoise) species occurring in the region.

9.6.61 The intertidal area at Donna Nook is the main haul out site in the region and is an important breeding ground for grey seals. This colony is located over 25 km from the proposed development at the mouth of the Humber Estuary. In 2019, there were an estimated 67,789 grey seal pups born in Britain (SCOS, 2022) with approximately 3% of the pup production occurring at Donna Nook. Breeding occurs once a year between October and December and the vast majority of seals in this colony breed at Donna Nook, with a few seals breeding on Skidbrooke Ridge, south of Donna Nook. Peak grey seal pup numbers in winter 2021/22 and 2020/21 at Donna Nook consisted of 2,122 and 2,214 seals respectively with numbers having increased substantially in recent years from under 100 pups born annually in the 1980s (Figure 9.6 to this chapter).

9.6.62 The intertidal mudflats also provide an important habitat throughout the year for grey seals to haul out or rest, particularly during the spring when all grey seals (except young born the previous year) are moulting. Aerial seal counts undertaken in August 2021 recorded 3,897 grey seals hauled out at Donna Nook. Totals numbers at this colony have increased from the low hundreds recorded in the late 1990s and early 2000s to counts over 4000-5,000 seals in more recent years (SCOS, 2022) (Figure 9.7 to this chapter).

9.6.63 Grey seals can undertake wide ranging seasonal movements over several thousand kilometres (McConnell *et al*. 1999; Carter *et al*., 2020; Russel, 2016). However, while grey seals may range widely between haul out sites, tracking has shown that most foraging probably occurs within 100 km of a haul-out site (SCOS, 2017). Seals tagged at Donna Nook were recorded undertaking wide ranging movements in the outer Humber Estuary and approaches as well as more widely in the North Sea (Russel, 2016). This is reflected in high predicted at-sea densities of grey seals in the approaches to the Humber Estuary (Carter *et al.,* 2020).

9.6.64 The Humber Estuary region also supports a small population of common seal. As for the grey seal, Donna Nook is also the key haul out site for common seals. A total of 122 common seals were recorded as part of annual aerial monitoring in the region in August 2021. Since the 1990s numbers have generally fluctuated between 100 and 400 counts annually in the region (SCOS, 2022). Common seals typically forage within 40 to 50 km of haul out sites (SCOS, 2022).

Cetaceans

9.6.65 While over ten species of cetacean have been recorded in the southern and central North Sea, only harbour porpoise *Phocoena phocoena* is considered as regularly occurring throughout most of the year (Evans and Bertulli, 2021; DECC, 2016; Waggitt *et al*., 2020).

9.6.66 Near to the Humber Estuary, high densities of harbour porpoise have been recorded offshore from the Lincolnshire coast and the Holderness Coast (Hammond *et al*., 2021; Heinänen and Skov, 2015). Harbour porpoise are also frequently recorded foraging in the Humber Estuary region with over 2,000 sightings since 2000 (Evans and Bertulli, 2021; NBN, 2021; LERC, 2021). Peak sightings and numbers occur in August, September and October. Although porpoises in the North Sea can give birth in any month of the year, breeding is typically seasonal with most births in June or July and a peak in mating in August (Evans and Bertulli, 2021).

9.6.67 Other cetacean species recorded in the Humber Estuary region more rarely include bottlenose dolphin *Tursiops truncatus*, common dolphin *Delphinus delphis*, white-beaked dolphin *Lagenorhynchus albirostris* killer whale *Orcinus orca* and minke whale *Balaenoptera acutorostrata* (Evans and Bertulli, 2021; LERC, 2021).

Immingham area

9.6.68 Marine mammal survey data or sighting records for the Immingham area are limited. However, given that seals (particularly grey seals) are regularly recorded foraging in the Humber Estuary, this species would be expected to occur relatively frequently in this area. For example, approximately 10 to 15 grey seals were observed hauling out on mudflat at Sunk Island (on the north bank of the Humber Estuary) during the project specific benthic surveys as detailed in Appendix 9.1 to the ES. This haul out site is located approximately 4 km north east from the proposed development and around

3 - 4 km from the dredge disposal sites (including transit routes). No seal haul out sites are known to occur nearer to the proposed development.

9.6.69 Harbour porpoises have also been regularly recorded foraging in this section of the Humber Estuary (Evans and Bertulli, 2021) (Figure 9.8). This includes observations of a harbour porpoise foraging approximately 2 km from the proposed development in the mid channel, offshore from Immingham during the project specific benthic surveys as detailed in Appendix 9.1 to the ES.

Coastal waterbirds

Humber Estuary overview

9.6.70 The Humber Estuary is a site of national and international importance for its waders and wildfowl (ducks and geese) populations, regularly supporting over 130,000 waterbirds during winter and passage periods (Frost *et al.*, 2021; Woodward *et al.,* 2018).

9.6.71 Waterbird numbers are highly variable in the Humber Estuary throughout the year, but it is considered to be an important site year-round due to the presence of different populations of wintering, passage and breeding birds which move into and out of the estuary. In general, numbers of coastal waterbirds are at their lowest during June, when the assemblage is dominated by wildfowl, before numbers start increasing during July due to the return of waders such as Dunlin. Golden Plover start to become more abundant in late summer. The arrival of wintering waterfowl such as Pink-footed Geese and Wigeon as well as wader species such as Knot typically occurs in early autumn. Numbers start to fall in late winter with the departure of species such as Golden Plover and Knot, before increasing slightly in spring as passage flocks start to move through the area and wildfowl depart (Natural England, 2021b).

9.6.72 Table 9.18 provides summary ecology information on key waterbird species occurring in the Humber Estuary in intertidal and marine habitats. This includes the 5-year estuary-wide mean peaks for these species for 2015/16 to 2019/20 (the most recent 5-years of data available from the BTO) (Frost *et al.,* 2021)[7].

[7] It should be noted that as a result of COVID-19 lockdowns, the BTO were unable to undertake a full survey programme and therefore produce robust data for 2020/21 at an estuary-wide scale and therefore the period 2015/16 to 2019/20 is the most recent 5 years of data available from the BTO.

Table 9.18. Summary information for key species of coastal waterbird in the Humber Estuary

Species group	Species	Feeding behaviour in the marine environment [1]	Diet [2]	Distribution in the Humber Estuary [3]	Month of peak count [4]	WeBS Core Count 5-year estuary-wide mean peaks (2015/16 to 2019/20) [5]
Wader	Golden Plover	Roosts but rarely feeds in the intertidal	Mainly insects, especially beetles, as well as other invertebrates and some plant material.	Golden Plover mainly uses the estuary to roost in areas including Alkborough Flats, Whitton Sands, Blacktoft Sands, Read's Island in the Inner Humber Estuary and Salt End, Stone Creek, Paull Holme Stray, Cherry Cobb Sands and Pyewipe in the Middle Humber.	Oct-Dec	31,237
	Knot	Intertidal benthivore	Mainly molluscs, including the bivalve *Limecola balthica*, cockles *Cerastoderma edulis* and mud snail *Peringia ulvae*, the latter especially in early winter. Diet proportions of 75% bivalves, 1% worms and 24% 'other'. Prey is eaten whole and crushed within the gizzard.	Knot is found in the outer Humber including Cherry Cobb Sands and the Lincolnshire coast south of Grimsby. Easington Lagoons provide an important roost site for Knot during high spring tides.	Jan, Mar, Nov-Dec	22,500

Species group	Species	Feeding behaviour in the marine environment [1]	Diet [2]	Distribution in the Humber Estuary [3]	Month of peak count [4]	WeBS Core Count 5-year estuary-wide mean peaks (2015/16 to 2019/20) [5]
	Lapwing	Roosts but rarely feeds in the intertidal	Wide range of invertebrates including beetles and earthworms.	Lapwing mainly uses the estuary to roost in areas including Alkborough Flats, Whitton Sands, Blacktoft Sands and Read's Island in the Inner Humber Estuary as well as Salt End, Stone Creek, Paull Holme Stray, Cherry Cobb Sands and Pyewipe (all Middle Humber Estuary). The majority of feeding occurring inland, though some feeding on intertidal areas takes place during July to September.	Jan-Feb, Dec	16,453
	Dunlin	Intertidal benthivore	Oligochaetes, polychaete worms (such as *Hediste diversicolor, Nephtys* spp., *Pygospio elegans* and *Scoloplos armiger*), bivalves (such as *Limecola balthica*) and the mud snail *Peringia ulvae*. Diet proportions of	Widespread with important areas including Read's Island (Inner Humber Estuary), Cherry Cobb Sands, Pyewipe, Stone Creek and Salt End (all Middle Humber Estuary) and Saltfleet (Outer Humber Estuary).	Aug, Nov-Dec	15,954

Species group	Species	Feeding behaviour in the marine environment [1]	Diet [2]	Distribution in the Humber Estuary [3]	Month of peak count [4]	WeBS Core Count 5-year estuary-wide mean peaks (2015/16 to 2019/20) [5]
			70% worms, 14% bivalves and 16% 'other'.			
	Oyster-catcher		Predominantly bivalves especially large cockles *Cerastoderma edule*, mussels *Mytilus edulis* and tellins *Limecola* spp. Diet might also include polychaete worms on mudflats and earthworms from wet fields.	Found predominantly in the Outer Humber Estuary. The most important areas for Oystercatcher are along the Lincolnshire coast.	Feb, Sep-Dec	5,816
	Black-tailed Godwit		Invertebrates, including beetles, polychaete worms (such as *Hediste diversicolor, Nephtys, Pygospio elegans* and *Scoloplos armiger*), molluscs (such as *Limecola balthica)* crustaceans and some plant material.	Key areas include Pyewipe and North Killingholme Haven Pits for this species during winter.	Aug-Oct	4,545

Species group	Species	Feeding behaviour in the marine environment [1]	Diet [2]	Distribution in the Humber Estuary [3]	Month of peak count [4]	WeBS Core Count 5-year estuary-wide mean peaks (2015/16 to 2019/20) [5]
	Grey Plover		Polychaete worms (such as *Hediste diversicolor* and *Arenicola marina*), bivalves (such as *Limecola balthica*) and the muds snail *Peringia ulvae*.	Widespread usage across the Middle and Outer parts of the Humber Estuary. Typically, more usage of the north bank compared to the south bank. Particular key areas include Cherry Cob Sands, and Welwick.	Jan, Mar, May, Sep	3,179
	Redshank		Polychaete worms (such as *Hediste diversicolor, Nephtys spp., Pygospio elegans and Scoloplos armiger*), the bivalve *Limecola balthica,* crustaceans (such as brown shrimp *Crangon crangon and* mud shrimp *Corophium* spp.*) and* the mud snail *Peringia ulvae*. Will also consume terrestrial invertebrates, including insects and spiders. Diet proportions of	Widespread with key areas including Cherry Cobb Sands and in the outer Humber Estuary.	Sep-Oct, Dec	2,881

Species group	Species	Feeding behaviour in the marine environment [1]	Diet [2]	Distribution in the Humber Estuary [3]	Month of peak count [4]	WeBS Core Count 5-year estuary-wide mean peaks (2015/16 to 2019/20) [5]
			46% worms, 7% bivalves and 47% 'other'.			
	Curlew		Primarily bivalves (such as *Cerastoderma edule* and *Limecola balthica)*, the ragworm *Hediste diversicolo*r and lugworm *Arenicola marina).* Earthworms on terrestrial habitats, Diet proportions during winter of 46% bivalves, 35% worms and 19% 'other'.	Important areas include Cherry Cobb sands and Patrington to Easington (Outer North), Read's Island (Inner Humber), Pyewipe, Salt End (both Middle Humber) and Theddlethorpe St. Helen (Outer South).	Jan, Jul, Sep	2,787
	Avocet		Benthic crustaceans e.g., *Corophium* spp. and worms such as ragworm *H. diversicolo*r. Insects, especially Chironomidae larvae, in freshwater habitats.	Largest wintering flocks are present in the inner Humber around Far Ings/Read's Islands, close to the favoured locations for breeding.	Aug-Oct	2,479

Species group	Species	Feeding behaviour in the marine environment [1]	Diet [2]	Distribution in the Humber Estuary [3]	Month of peak count [4]	WeBS Core Count 5-year estuary-wide mean peaks (2015/16 to 2019/20) [5]
	Bar-tailed Godwit		Polychaete worms are the principal food source during winter such as *Hediste diversicolor, Nephtys, Pygospio elegans and Scoloplos armiger*. Diet proportions comprise 94% worms. Other species sometimes consumed include the shrimp *Crangon crangon* and bivalve *Limecola balthica.*	The most important sectors for Bar-tailed Godwit are the three sectors that make up the Outer (North) area, and the adjacent Cherry Cobb Sands (Middle Humber), and Paull Holme Strays (also Middle Humber).	Feb, Sep, Nov	1,561
	Ringed Plover		In winter, mainly marine worms, crustaceans (such as *Corophium* spp.) and molluscs (such as *Peringia ulvae*).	Most commonly recorded in the Outer Estuary.	Aug-Sep	731
	Sanderling		Polychaete worms (such as *Hediste diversicolor*), crustaceans and insects. Diet	Within the Humber Estuary, Sanderling are found exclusively in the outer estuary, particularly on the	May, Jul-Aug, Dec	579

Species group	Species	Feeding behaviour in the marine environment [1]	Diet [2]	Distribution in the Humber Estuary [3]	Month of peak count [4]	WeBS Core Count 5-year estuary-wide mean peaks (2015/16 to 2019/20) [5]
			proportions comprise 60% worms, 1% molluscs and 39% 'other'.	sandflats of the Lincolnshire coast.		
	Turnstone		A wide range of invertebrates and other food sources. This includes polychaete worms and mudshrimp *Corophium* spp. on mudflats. Also feeds on rocky shore species, including mussels, amphipods, molluscs (such as periwinkles) and crabs. Diet proportions comprise 20% bivalves, 5% worms and 75% 'other'.	Key areas for Turnstone include rocks around New Holland between Barton upon Humber and East Halton (Middle Humber) and between Grimsby and Cleethorpes (Outer South). Also feed on jetties and around the harbours.	Feb, Sep, Nov-Dec	239
	Whimbrel		On passage the species consumes shrimps, molluscs, worm and crabs.	No obvious preferred areas, found throughout the Humber during migration periods.	Jul-Aug	110

Species group	Species	Feeding behaviour in the marine environment [1]	Diet [2]	Distribution in the Humber Estuary [3]	Month of peak count [4]	WeBS Core Count 5-year estuary-wide mean peaks (2015/16 to 2019/20) [5]
	Ruff	Intertidal benthivore on mudflats but omnivores more generally	Omnivore feeding on insects, larvae, frogs, small fish and seeds.	The Humber Estuary is considered an important site for passage Ruff. The most important areas of the Humber for the ruff are the intertidal mud and sand flats and adjacent lagoons of Alkborough Flats and Blacktoft Sands with smaller numbers also observed wintering along the River Trent, at North Killingholme and at Tetney). During autumn, Paull Holme Strays, Sunk Island, Read's Island, New Holland and Whitgift Sand on the River Ouse are also important areas.	Aug-Oct	80
Water-fowl	Pink-footed Goose	Herbivorous waterfowl	Herbivorous. Outside the breeding season this species feeds on improved grasslands, cereal stubbles and vegetables (e.g., potatoes, sugar beet, carrots).	Recorded mainly on Read's Island, which it uses as a roosting site, flying inland during the day to feed in fields.	Oct-Nov	14,345

Species group	Species	Feeding behaviour in the marine environment [1]	Diet [2]	Distribution in the Humber Estuary [3]	Month of peak count [4]	WeBS Core Count 5-year estuary-wide mean peaks (2015/16 to 2019/20) [5]
	Shelduck	Intertidal benthivore	Invertebrates, with small molluscs predominant in north and west Europe, especially mud snail *Peringia* spp. Other species consumed include the mud shrimp *Corophium volutator*, bivalves and polychaetes.	Shelduck are found throughout the estuary with key areas including Read's Island and Alkborough Flats (Inner Humber) and at Pyewipe, Salt End, Cherry Cobb Sands and Paull Holme Sands (Middle Humber).	Jul-Aug, Oct-Nov	4,515
	Teal	Omnivorous waterfowl	Seeds of saltmarsh and other wetland plants, including glasswort Salicornia spp. and oraches *Atriplex* spp., and invertebrates (especially small oligochaetes) sifted from the benthos.	Key areas include Alkborough Flats, Read's Island and Blacktoft Sands.	Sep-Nov	3,757
	Dark-bellied Brent Goose	Herbivorous waterfowl	Mainly grasses, and on arable land the shoots of winter cereals, and oilseed rape. On estuaries, eelgrass	The North Lincolnshire coast between Tetney and Donna Nook is a key area. Spurn is also important during spring passage.	Jan, Nov-Dec	3,092

Species group	Species	Feeding behaviour in the marine environment [1]	Diet [2]	Distribution in the Humber Estuary [3]	Month of peak count [4]	WeBS Core Count 5-year estuary-wide mean peaks (2015/16 to 2019/20) [5]
			Zostera spp. and saltmarsh plants.			
	Wigeon		Plants (leaves, stems, stolons, bulbils and rhizomes).	Alkborough Flats and Read's Island as well as Faxfleet to Brough Haven (also Inner Humber) are key areas.	Jan-Feb, Sep, Nov	2,672
	Greylag Goose		Grass, roots, cereal leaves and spilled grain.	Present within the Inner Humber to a greater extent (e.g., Faxfleet). Present in greatest numbers close to freshwater pools.	Aug-Sep, Nov	1,595
	Mallard	Omnivorous waterfowl	Omnivorous, including both plants and animal matter.	Occurs throughout Humber Estuary, with key areas including the River Ouse and Cherry Cobb Sands. The area around the outfall at New Holland is also a favoured area where the birds feed on grain spill from the dock.	Jan-Feb, Sep, Nov-Dec	1,046
	Barnacle Goose	Herbivorous waterfowl	The leaves and stems of grasses, roots and seeds.	Present on fields/arable land around the entire Humber Estuary in low densities.	Jan-Mar, Sep	878
	Common Scoter	Benthivorous diving duck	Molluscs.	Present within the Outer Humber due to their more pelagic lifestyle. Occurs in passage and winter.	Mar, Oct-Dec	682

Species group	Species	Feeding behaviour in the marine environment [1]	Diet [2]	Distribution in the Humber Estuary [3]	Month of peak count [4]	WeBS Core Count 5-year estuary-wide mean peaks (2015/16 to 2019/20) [5]
	Canada Goose	Herbivorous waterfowl	Roots, grass, leaves and seeds.	Occurs within the Inner Humber in the largest numbers. Present in greatest numbers close to freshwater pools.	Jun, Sep	641
	Goldeneye	Benthivorous diving duck	Mostly aquatic insects, molluscs and crustaceans. Occasional fish. Plant material generally less than 25%.	Goxhill to New Holland and Barrow to Barton (including Barton Pits) are key areas.	Jan, Dec	329
Gull	Black-headed Gull	Omnivorous/ scavenging gull	Worms, insects, small fish, crustacea and carrion.	Widely distributed.	Aug-Sep	11,217
	Common Gull		Worms, insects, fish and carrion.	Widely distributed.	Aug-Oct, Dec	1,599
	Herring Gull		Carrion, offal, seeds, fruits, young birds, eggs, crustaceans, small mammals, insects and fish.	Widely distributed.	Jan, Apr, Sep, Dec	1,015
	Great Black-backed Gull		Shellfish, birds and carrion.	Widely distributed.	Sep-Dec, Feb	292
Terns, and other	Sandwich Tern	Piscivorous plunge diver	Fish such as sandeels, sprats and whiting.	Widely distributed.	Jul-Aug	686

Species group	Species	Feeding behaviour in the marine environment [1]	Diet [2]	Distribution in the Humber Estuary [3]	Month of peak count [4]	WeBS Core Count 5-year estuary-wide mean peaks (2015/16 to 2019/20) [5]
diving birds	Common Tern		Fish and crustaceans in some areas.	Widely distributed.	Aug-Sep	476
	Cormorant	Piscivorous pursuit diver	Feeds on fish such as flatfish, blennies gadoids, sandeel, salmonid and eels.	Widely distributed.	Jan-Feb, Sep, Nov	323
	Red-throated Diver	Piscivorous pursuit diver	Diet consists predominantly of fish (mainly clupeids, mackerels, flatfish, gadoids and sand eels).	Recorded mainly in the outer Humber Estuary and approaches.	Jan-March	39

1. Feeding behaviour based on Mander *et al. (*2021) and Camphuysen *et al*. (1999):

Intertidal benthivore: Waterbird species feeding on infaunal and/or epibenthic invertebrates in intertidal habitats;
Herbivorous waterfowl: Geese, swans and ducks feeding on plant material;
Omnivorous waterfowl: Ducks feeding on a range of animal and plant food;
Benthivorous diving duck: Diving ducks/seaducks feeding on epibenthic and infaunal invertebrates on the seabed;
Omnivorous/scavenging gull: Gulls feeding on a range of animal and plant food including through scavenging;
Piscivorous plunge diver: Seabirds foraging for fish through plunge diving; and
Piscivorous pursuit diver: Seabirds foraging for fish through pursuit diving.

2. Based on Stillman *et al*. (2005); Woodward *et al*. (2014) and RSPB (2021).

3. Based on Woodward *et al.* (2014) and Natural England Designated Sites Viewer [redacted]

4. Months when peaks count occurred in the 2015/16 to 2019/20 estuary-wide BTO Core Counts (Frost *et al.,* 2021).

5.Data from Frost *et al.* (2021).

9.6.73 The most abundant wading bird species recorded in the Humber Estuary are Golden Plover and Knot (5-year mean peak for 2015/16 to 2019/20 of 31,237 and 22,500 birds respectively). Other wading birds occurring in large numbers include Lapwing (5-year mean peak of 16,453 birds) and Dunlin (5-year mean peak of 15,954 birds) as well as Oystercatcher, Black-tailed Godwit, Grey Plover, Curlew, Avocet and Bar-tailed Godwit (Frost *et al.,* 2021). Important areas for feeding and roosting waders include the Pyewipe frontage on the south bank and Paull Holme, Cherry Cobb, Foulholme, Spurn and Sunk Island Sands on the north bank of the Humber Estuary. In the inner section of the Humber Estuary, sites such as Blacktoft Sands, Alkborough and Read's Island Flats are considered important (Natural England, 2021b). The numbers of different waders in the Humber Estuary can show a high degree of interannual variation with some species (such as Black-tailed Godwit, Avocet, Oystercatcher) showing an overall long-term increase in estuary wide numbers with other species such as Dunlin, Redshank and Knot showing an overall decline (Woodward *et al*., 2018; Woodward *et al*., 2019a).

9.6.74 Key prey items for waders on the Humber Estuary include annelid worms (such as ragworm *Hediste diversicolor*, lugworm *Arenicola marina*, *Pygospio elegans, Streblospio shrubsolii, Tubificoides* spp., and *Nephtys* spp), the bivalves *Cerastoderma edule* and *Limecola balthica*, the mudsnail *Peringia* spp. and mud shrimp *Corophium* spp. (Stillman *et al*., 2005; Woodward *et al*., 2014).

9.6.75 The most abundant wildfowl bird species recorded in the Humber Estuary are Pink-footed Goose and Shelduck (5-year mean peak of 14,345 and 4,515 birds respectively). The number of Shelduck in the Humber Estuary has remained relatively stable with Pink-footed Goose showing a long-term increase (Woodward *et al.*, 2018; Woodward *et al*., 2019a). Other commonly occurring wildfowl include Teal, Dark-bellied Brent Geese, Wigeon, Greylag Goose and Mallard (Frost *et al.,* 2021). Pink-footed Goose are recorded in large numbers at Read's Island with Dark-bellied Brent Geese and Wigeon, principally occur in areas along the southern shore from Cleethorpes to Saltfleetby (Natural England, 2021b).

9.6.76 Black-headed Gull (5-year mean peak of 11,217 birds) as well as Herring Gull and Common Gull (occurring in lower numbers) are widespread in the Humber Estuary.

9.6.77 The Humber Estuary also supports several heron species including Grey Heron, Little Egret and Great Bittern. Grey Heron and Little Egret are recorded in a wide variety of intertidal and coastal habitats with Great Bittern recorded within reedbed habitats such as around Blacktoft Sands, Far Ings, Barton and North Killingholme Haven clay pits (Natural England, 2021b).

9.6.78 Diving birds occurring in the Humber Estuary include Common Scoter and Goldeneye (5-year mean peak of 682 and 329 birds respectively) with Cormorants and Tufted Duck also occurring in relatively large numbers.

9.6.79 Little Tern breed at Easington Lagoon, which is located approximately 20 km from the proposed development (Natural England, 2021b), with data suggesting this species forages within 5 km of nesting sites (Woodward *et al*., 2019b). Sandwich Tern (5-year mean peak of 686 birds) and Common Tern (5-year mean peak of 476 birds) are also regularly recorded, particularly in passage periods in the Humber Estuary.

Immingham area

9.6.80 Pre and post consent monitoring of coastal waterbird surveys as part of the IOH development have been undertaken annually since winter 1997/98. The foreshore in the area of the proposed development overlaps with part of 'Sector B' (between Marsh Lane (Immingham) Western Jetty to the IOT Jetty (as shown in Figure 9.1 to this chapter). The most recent 5-years of data (2017/18 to 2021/22) has been analysed for this sector (Table 9.19). During this period, surveys were undertaken between October and March twice a month[8]. During each survey, either five counts (October and March) or four counts (November to February) were undertaken every two hours after high water. In addition, the 2021/22 survey season started early in August rather than October. The surveys have been continued on a monthly basis in 2022 rather than stopping in March as per previous years. On this basis, the results from passage and summer months (August and September 2021 and April to September 2022) have been presented separately (Table 9.20).

9.6.81 To summarise the findings from the survey work, the annual peak count (maximum count from each winter period between October and March) for birds feeding, roosting as well as the combined total[9] is presented in Table 9.19. The 5-year average of the annual peak counts for each species (referred to as the mean peak-MP) [10] is also presented in Table 9.19. This table also compares the 5-year mean peak against the thresholds and values outlined below, to provide objective criteria to help determine the value of the area in an international (bullet one), national (bullet two) and regional context (bullet three):

8 Passage surveys have been undertaken on a weekly basis in March and April 2022 and will also be undertaken on a weekly basis from September to November 2022 to provide further data on abundances during these periods.

9 The combined peak count is a summed value derived from the largest count of both feeding and roosting birds during the same hourly count.

10 It is standard practice to present the average of the annual peaks for a certain duration of time (sometimes referred to as the mean of peaks). This is calculated as the average of the maximum annual counts and for the most recent 5-years of available data if possible. Mean peaks (using five years of winter values) is the approach presented in the WeBS annual reports. For most migratory species, the WeBS 5-year mean of peak is also the value that is used when identifying qualifying features for each SPA. Using mean of peaks is also useful for characterising the relative importance of sectors within a site, as it gives a good indication of how many individuals of a given species a sector typically supports (Austin and Ross-Smith, 2014).

- **Internationally Important Threshold Level**: The threshold for an individual species (or subspecies) is set at 1% of the biogeographic population[11];
- **Nationally Important Threshold Level:** The threshold for an individual species (or subspecies) is set at 1% of the British population i.e. if a site supports more than 1% of the British population it is considered Nationally Important (for that species or subspecies);
- **Latest Humber Estuary WeBS Core Counts 5-year average:** The 5-year mean peak from the latest Humber Estuary WeBS Core Counts. Core Count surveys are typically undertaken around high water. Within this assessment, this is from 2015/16 to 2019/20 (Frost *et al.,* 2021). It should be noted that as a result of COVID-19 lockdowns, the BTO were unable to undertake comprehensive counts and therefore produce robust data for 2020/21 at an estuary-wide scale and therefore the period 2015/16 to 2019/20 is the most recent 5 years of data available from the BTO. For the purposes of this assessment, numbers representing more than 10% of the estuary-wide Core Counts for an individual species are considered regionally important and numbers representing between 1% and 10% are considered locally important [12].

9.6.82 The 5-year mean peak number of birds in Sector B during different months is presented Figure 9.9 to this chapter to show any seasonal trends over the winter period. The distribution of birds within Sector B based on distribution data collected in the surveys is shown in Figure 9.10 of this chapter.

9.6.83 During the surveys, over 20 waterbird species have been recorded on the foreshore within Sector B with approximately 15 species considered regularly occurring.

9.6.84 The most abundant wading bird species recorded foraging within Sector B over this period were Black-tailed Godwit and Dunlin (5-year mean peaks of 574 and 369 birds respectively). In the winter of 2017/18 and 2019/20 Black-tailed Godwit were recorded in nationally important numbers (419 and 563 birds respectively), with internationally important numbers occurring in winter 2021/22 (1,300 birds) (Table 9.19 of this chapter). Other wading birds recorded included Redshank, Turnstone, Oystercatcher and Curlew. Shelduck were the most abundant wildfowl species recorded foraging (5-year mean peak of 69 birds). Lower numbers of other ducks such as Teal and Mallard were also recorded.

[11] The thresholds levels are available at: [redacted] It should be noted that, where 1 % of the population is less than 50 birds, 50 is normally used as a minimum qualifying threshold for the designation of sites of national or international importance (accessed 04/04/22).

[12] The 1% local threshold has been requested to be used in the baseline data analysis by Natural England as part of previous developments on the Humber Estuary.

Table 9.19. Coastal waterbird species recorded within Sector B during the last five winters

Species	Peak count per winter (feeding)						Peak count per winter (roosting)						Peak count per winter (combined – non-behavioural)					
	17/18	18/19	19/20	20/21	21/22	MP	17/18	18/19	19/20	20/21	21/22	MP	17/18	18/19	19/20	20/21	21/22	MP
Bar-tailed Godwit	29	2	22	10	8	14	2		12	12	1	5	29	2	22	12	8	15
Black-tailed Godwit	419	286	563	303	1300	574	12	6	222	3	38	56	419	286	563	303	1300	574
Cormorant		4	3	2	2	2	19	14	6	14	14	13	19	14	7	14	14	13
Curlew†	12	12	12	11	12	12	4	6	7	8	7	6	12	12	12	11	12	12
Dunlin	417	270	115	638	406	369	330	120	2	300	494	249	417	270	115	638	494	387
Golden Plover										1		<1				1		<1
Greenshank†			1			<1									1			<1
Grey Heron			1	1		<1	1			1		<1	1		1	1		1
Grey plover†	1	1		1	1	1		1		1		<1	1	1		1	1	1
Knot	3		23	14		8			4	10		3	3		23	14		8
Lapwing†	3					1	3		1			1	3		1			<1
Little Egret									1			<1			1			<1
Mallard†	2	4	8			3		6	2		7	3	2	8	8		7	5
Mute swan								1				<1		1				<1
Oystercatcher†	5	8	10	8	12	9	3	5	6	4	4	4	6	8	10	9	12	9
Redshank	184	204	166	125	142	164	130	110	121	110	153	125	184	204	184	125	160	171
Ringed Plover†	7	12	1	7		5							7	12	1	7		5
Shelduck	84	69	56	70	67	69	69	74	39	45	46	55	84	74	58	86	72	76
Spotted Redshank	1					<1							1					<1
Teal†		11	21	9	21	12	2	1	9	3	27	8	2	11	21	9	27	14
Turnstone†	22	35	33	29	28	29	5	15	5	6	2	7	22	35	33	29	28	29

SPA qualifying species highlighted in **bold.** † Species with this symbol are included within the SPA waterfowl assemblage.

	Cells highlighted green indicate the count is of local importance (> 1%) of the current estuary wide WeBS 5-year MP.
	Cells highlighted orange indicate the count is of regional importance (> 10%) of the current estuary wide WeBS 5-year MP.
	Cells highlighted blue indicate the count is of national importance. It should be noted that for Black-tailed Godwit the regional importance (> 10% of the estuary wide WeBS 5-year MP – 455 birds) is higher than the national importance threshold (390 birds). The national importance threshold for Spotted Redshank is set as 1.
	Cells highlighted red indicate the count is of international importance.

9.6.85 With respect to roosting birds, Dunlin and Redshank were the most numerous species recorded (5-year mean peaks of 249 and 125 birds respectively). Other species regularly recorded roosting included Shelduck (5-year mean peak of 55 birds) as well as Black-tailed Godwit, Curlew and Turnstone.

9.6.86 As shown in Figure 9.9, during the surveys, the largest numbers of wintering Dunlin were generally recorded from December to February. Wintering Black-tailed Godwit numbers were typically highest in October and March but have been recorded in peak numbers in other months in some years. The numbers of other wintering species were highly variable with no clear pattern.

9.6.87 The data collected during passage and summer periods (August to September 2021 and April to September 2022) recorded a range of species some of which were recorded in relatively large numbers (Table 9.20). For example, peak counts of 143 Redshank were recorded in September 2022 (and also August 2022 and September 2021), respectively (which is approaching the winter 5-year mean peak of 171 birds). A peak of 34 Turnstone and 535 Black-tailed Godwit was recorded during September 2022 and April 2022, respectively. These passage peaks are broadly the same number of birds as the winter 5-year mean peak for both species). Other species such as Dunlin were recorded in lower numbers during this period (peak of 108 birds, compared to a 5-year mean peak of 387 birds during winter). Ringed Plover typically have a late spring migration period through the Humber, with the peak count of 72 birds occurring in May. Very few Ringed Plover have been recorded during winter periods within Sector B (5-year mean peak of seven birds).

9.6.88 All of the species observed in Sector B are frequently recorded in large numbers during both passage and winter periods in the Humber Estuary more widely with the estuary-wide peak abundances of passage birds typically showing a high degree of both monthly and annual variability. This would be expected given the more transient nature of passage birds with numbers fluctuating on a daily basis as birds arrive and depart from sites in the Humber Estuary (Woodward *et al.,* 2018).

9.6.89 The highest densities of feeding and roosting birds in the sector typically occur on the intertidal mudflats in the eastern section of the foreshore fronting Immingham Docks (between the Inner Dock entrance and the IOT Jetty). Most foraging waterbirds typically cluster along the tideline and use the entire area extensively for feeding. Unlike other waders recorded in this area which rely on mudflat habitat for feeding, Turnstones will also feed around higher elevation (upper shore) hard substrate habitats in the area (including supporting beams on jetty structures) and the bottom of the seawall.

9.6.90 Much lower numbers of waterbirds have been recorded west of the lock gate with flocks of Turnstone (which often show a preference for the sea defence/mud interface in this area) and occasional individuals of Dunlin,

Curlew and Redshank recorded. It should also be noted that the foreshore to the east of the IOT jetty within approximately 300 m of the proposed development is used by very low numbers of birds based on data collected as part of the IOH ornithological monitoring of Sector C (which overlaps with this area). Observations from these surveys have recorded typically less than a total of 10 birds with individuals or small flocks of mainly Redshank, Curlew and Oystercatcher occurring.

9.6.91 Waders tend to loaf on a slightly higher elevation area of mudflat before this becomes inundated at high water with low numbers moving to the seawall to roost and others dispersing to other areas. Waterbirds also cluster on the seawall during the ebbing tide waiting for mudflat habitat to be exposed. An outfall pipe is also used by roosting Cormorants and gulls. In addition, Turnstone and gulls use derelict concrete structures present on the mudflat (Figure 9.10).

9.6.92 The assemblage recorded in the surveys is broadly similar to that recorded during the WeBS Core Counts for the period 2016/17 to 2020/21 (the most recent 5-years of data available from the BTO for the 'Immingham Docks Sector K'). The most commonly recorded species were Dunlin (mean peak of 165 birds), Redshank (mean peak of 83 birds), Black-tailed Godwit (mean peak of 47 birds) Shelduck (mean peak of 35 birds), Turnstone (mean peak of 44) and Curlew (mean peak of 11 birds). It is worth noting that this WeBS sector covers a much larger area than Sector B and so it is not directly comparable in terms of spatial extent [13]. Core counts are also only typically undertaken around high water periods and so do not provide information through the tide or during low water periods.

9.6.93 The highest densities of feeding and roosting birds in Sector B typically occur on the intertidal mudflats in the eastern section of the foreshore fronting Immingham Docks (between the Inner Dock entrance and the IOT Jetty). Most foraging waterbirds typically cluster along the tideline and use the entire area extensively for feeding. Unlike other waders recorded in this area which rely on mudflat habitat for feeding, Turnstones will also feed around higher elevation (upper shore) hard substrate habitats in the area (including supporting beams on jetty structures) and the bottom of the seawall.

9.6.94 Waders tend to loaf on a slightly higher elevation area of mudflat before this becomes inundated at high water with low numbers moving to the seawall and others dispersing to other areas. An outfall pipe is also used by roosting Cormorants and gulls. In addition, Turnstone and gulls use derelict concrete structures present on the mudflat (Figure 9.10 to this chapter).

[13] The sector includes foreshore adjacent to the Port of Immingham and also extents east of the IOT terminal jetty [redacted]

Table 9.20. Coastal waterbird species recorded within Sector B during August to September 2021 and April to September 2022

Species	Peak count per passage month (feeding)								Peak count per passage month (roosting)								Peak count per passage (combined – non-behavioural)							
	Aug 21	Sept 21	Apr 22	May 22	Jun 22	Jul 22	Aug 22	Sept 22	Aug 21	Sept 21	Apr 22	May 22	Jun 22	Jul 22	Aug 22	Sept 22	Aug 21	Sept 21	Apr 22	May 22	Jun 22	Jul 22	Aug 22	Sept 22
Arctic Tern										1								1						
Bar-tailed Godwit		4					2	16								5		4					2	16
Black Headed Gull			30	18	107	171	224	210			2	5	29	34	168	65			30	18	107	171	224	210
Black-tailed Godwit	91	23	535	264	102	44	22	109	63		2	24	29	20	6	7	91	23	535	264	102	44	22	109
Common Gull				1	13	7	1	5			18		4		8	30			18	1	13	7	8	30
Common Sandpiper	4	2				3	1	5								4	4	2				3	1	5
Common Tern										30								30						
Cormorant	11	1	1					1	10	13	9	0	7	7	16	15	11	13	9		7	7	16	15
Curlew†	10	11	13	14	18	18	13	11	3	8	1	6	1	4	4	4	10	12	13	14	18	18	13	11
Dunlin		18	10	12			1	108		20	2	3				2		20	10	12			1	108
Great Black-backed Gull			1	1	1	1	2	2			1		1		3	12			2	1	1	1	3	12
Herring Gull			3	6	2	3	5	7			10	1	1	1	1	2			10	6	2	3	5	7
Knot						1																1		
Lesser Black-backed Gull			4	2	2	6	5	2			5	3	3	9	9	8			8	5	3	9	9	8
Little Egret		1					1	2								1		1					1	2
Little Ringed Plover			4	1	6	3													4	1	6	3		
Mallard†			2					3			4	1							4	1				3

Species	Peak count per passage month (feeding)								Peak count per passage month (roosting)								Peak count per passage (combined – non-behavioural)							
	Aug 21	Sept 21	Apr 22	May 22	Jun 22	Jul 22	Aug 22	Sept 22	Aug 21	Sept 21	Apr 22	May 22	Jun 22	Jul 22	Aug 22	Sept 22	Aug 21	Sept 21	Apr 22	May 22	Jun 22	Jul 22	Aug 22	Sept 22
Mediterranean Gull										0					4								4	
Oystercatcher†	4		8	4	5	5	2		1	0	2	2	1	1	3		4		8	4	5	5	3	
Redshank	97	143	124	1	6	111	143	143	83	110	107	1	1	74	57	123	130	143	140	1	6	111	143	143
Ringed Plover†	1	5		72			3	5				24					1	5		72			3	5
Shelduck	14	25	22	15	7	8	23	21	6	15	15	15	3		8	20	14	25	22	19	7	8	23	21
Teal†			16								2								16					
Turnstone†	30	18	24	2	5	29	17	34	16						4	2	30	18	24	2	5	29	17	34
Whimbrel	1			1								1		2			1			1		2		
SPA qualifying species highlighted in bold. † Species with this symbol are included within the SPA waterfowl assemblage.																								
	Cells highlighted green indicate the count is of local importance (> 1%) of the current estuary-wide WeBS 5-year MP.																							
	Cells highlighted orange indicate the count is of regional importance (> 10%) of the current estuary-wide WeBS 5-year MP.																							
	Cells highlighted blue indicate the count is of national importance. It should be noted that for Black-tailed Godwit the regional importance (> 1% of the WeBS 5-year MP – 455 birds) is higher than the national importance threshold (390 birds). The national importance threshold for Common Sandpiper and Whimbrel is set as 1.																							

9.7 Future baseline environment

9.7.1 In the absence of the IERRT project, the current marine coastal processes would remain the same as described in the Physical Processes assessment (Chapter 7 to this ES).

9.7.2 Marine species are likely to become increasingly vulnerable to anthropogenic pressures in the future due to the predicted effects of climate change and ocean acidification in combination with more local pressures. The 2020 MCCIP report card (MCCIP, 2020) highlighted the following changes to marine ecology receptors could potentially occur as a result of climate change:

- Sea-level rise could result in deeper waters and larger waves reaching saltmarsh and other intertidal habitats, causing erosion at the seaward edge;
- Changes in patterns of rainfall or temperature changing vegetation composition of coastal saltmarsh communities;
- Marine communities around the UK altering as ocean acidification increases;
- Changing sea temperatures resulting in range shifts for both benthic species and mobile species (such as fish, marine mammals). This could result in a decline of some cold-water species around certain parts of the UK and an increase in the prevalence of non-native species;
- Changing temperatures affecting spawning in some marine species as well as the timings of migrations;
- Coastal waterbirds showing north-easterly shifts in the winter distributions in Europe; and
- Changes in prey distribution and availability, resulting in range shifts in some regional populations of marine mammals, fish and seabirds.

9.7.3 Data suggests that ecological changes linked to climate change (such as range shifts) are already occurring although there is currently a high degree of uncertainty with respect to predicting the magnitude of potential effects in the future.

9.8 Consideration of likely impacts and effects

9.8.1 This section identifies the potential likely effects on marine ecology receptors as a result of the construction and subsequent operation of the proposed development which have been identified.

9.8.2 The Physical Processes assessment (Chapter 7 of this ES), Water and Sediment Quality assessment (Chapter 8 of this ES) and Underwater Noise assessment (Appendix 9.2 to this ES) have informed the outcomes of the marine ecology assessment.

9.8.3 Potential impacts on features of internationally designated sites (SACs, SPAs and Ramsar sites) have been assessed within the HRA which is

included with the DCO application (Application Document Reference number 9.6).

9.8.4 The nearest MCZ (Holderness Inshore) is located approximately 20 km from the proposed development and does not overlap with the zone of influence. Furthermore, there are no mobile FOCI that could overlap with any of the marine effects resulting from the proposed development. Overall, therefore, there is considered to be no potential for direct or indirect impacts on FOCI at this site. On this basis an MCZ Assessment is not considered to be required.

9.8.5 It is noted that the Killingholme Haven Pits Site SSSI which is located approximately 5 km away from the proposed development could be functionally linked to the mudflat habitat in the proposed development footprint with local populations of species such as Dunlin and Black-tailed Godwit potentially utilising both areas. However, Killingholme Haven Pits is considered too distant to be impacted directly by the proposed development (such as through potential disturbance effects). Based on the predicted magnitude of potential effects and proposed mitigation, indirect impacts on the SSSI (e.g., changes in local population levels resulting from changes in distribution or mortality) are also expected to be negligible.

9.8.6 The Lagoons SSSI is located approximately 20 km from the proposed development with Little Tern a notified feature of the SSSI. However, data suggests that this species forages within 5 km of nesting sites (Woodward *et al.*, 2019b) with this species considered very rare within the Immingham area. On this basis, this notified feature will not overlap with any potential direct or indirect changes resulting from the construction and operational activities associated with the proposed development which are limited to within the vicinity of the Port of Immingham.

9.8.7 Cumulative impacts on marine ecology receptors that could arise as a result of other coastal and marine developments and activities in the Humber Estuary combined with the IERRT are considered as necessary as part of the cumulative and in-combination effects assessment (Chapter 20 of this ES).

Construction phase

9.8.8 This section contains an assessment of the potential impacts to marine ecology receptors as a result of the construction phase of the IERRT project. Potential effects during the construction phase that are considered relevant are reviewed in Table 9.21. It should be noted that the table includes the rationale for the scoping in or out of individual pathways for further assessment in this ES.

9.8.9 It should be noted that the construction of the IERRT project may be completed in a single stage, or it may be sequenced such that the construction of the southernmost pier takes place at the same time as operation of the northernmost pier (see Chapter 3 of this ES).

However, all capital dredging (and associated disposal activity) will be undertaken at one time, before construction of the northernmost pier commences. Therefore, for all impact pathways relating to capital dredge or dredge disposal, the assessment will not be altered by a single or sequenced construction period. It should be noted that in the case of a sequenced construction, the overall duration of piling will be extended to 37 weeks. However, there will be no change in the overall peak levels of underwater noise generated by the construction of all three berths at once versus a sequenced construction (i.e., the magnitude of change). The underwater noise assessment for benthic habitats, fish and marine mammals has been assessed on the basis of the worst-case scenario and will not be altered by a sequenced construction period.

Table 9.21. Potential effects during construction scoped in / out of further detailed assessment in the Environmental Statement

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
Benthic habitats and species	Direct loss of intertidal habitat as a result of capital dredging and the piles	Capital dredge and piling	Yes	Capital dredging will cause a direct, albeit very small loss of intertidal habitat which will be changed to subtidal habitat as a result of the deepening. Piling will also result in the small loss of intertidal. This impact pathway has, therefore, been scoped into the assessment.
	Direct loss of subtidal habitat as a result of the piles	Piling	Yes	Piling will also result in the small loss of subtidal. This impact pathway has, therefore, been scoped into the assessment.
	Direct changes to benthic habitats and species as result of seabed removal during dredging	Capital dredge	Yes	Capital dredging causes the direct physical removal of marine sediments from the dredge footprint, resulting in the modification of existing marine habitats. The impacts to benthic fauna associated with the dredged material include changes to abundance and distribution through damage, mortality or relocation to a disposal site. This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	N/A	This pathway relates to changes in habitat resulting directly from seabed removal and is, therefore, not considered relevant to the dredge disposal activity. Potential effects resulting from sediment deposition at the disposal site are discussed below.
	Direct changes to benthic habitats and species as a result	Piling	No	Piling has the potential to result in the localised resuspension of sediment as a result of seabed disturbance. Sediment that settles out of suspension

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
	of sediment deposition			back onto the seabed as result of piling is expected to be negligible and benthic habitats and species are not expected to be sensitive to this level of change. This impact pathway has, therefore, been scoped out of the assessment.
		Capital dredge	Yes	Capital dredging has the potential to result in localised physical disturbance and smothering of seabed habitats and species (where the sediment settles out of suspension back onto the seabed). This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	Yes	Dredge disposal will result in the deposition of sediments which has the potential to cause physical disturbance and smothering of seabed habitats. This impact pathway has, therefore, been scoped into the assessment.
	Indirect loss or change to seabed habitats and species as a result of changes to hydrodynamic and sedimentary processes	Marine works (capital dredging and piles)	Yes	The capital dredge and pile structures have the potential to result in changes to hydrodynamic and sedimentary processes (e.g., flow rates, accretion and erosion patterns). Marine invertebrates inhabiting sand and mud habitat show different tolerance ranges to physiological stresses caused by tidal exposure and tidal elevation and, therefore, hydrodynamic and bathymetric changes caused by the dredging could affect the quality of marine habitats and change the distribution of marine species. This impact pathway has, therefore, been scoped into the assessment.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
		Dredge disposal	Yes	The disposal of dredged material at the marine disposal site has the potential to result in changes to hydrodynamic and sedimentary processes (e.g., water levels, flow rates, changes to tidal prism, accretion and erosion patterns). Marine invertebrates inhabiting sand and mud habitat show different tolerance ranges to physiological stresses caused by tidal exposure and tidal elevation and, therefore, hydrodynamic and bathymetric changes caused by the disposal could affect the quality of marine habitats and change the distribution of marine species. This impact pathway has, therefore, been scoped into the assessment.
	Changes in water and sediment quality	Piling	No	The negligible, highly localised and temporary changes in suspended sediment levels (and related changes in sediment bound contaminants and dissolved oxygen) associated with bed disturbance during piling is considered unlikely to produce adverse effects in any species. The potential for accidental spillages will also be negligible during construction through following established industry guidance and protocols. This impact pathway has, therefore, been scoped out of the assessment.
		Capital dredge	Yes	Changes in water quality during capital dredging could impact benthic habitats and species through an increase in suspended sediment concentrations (SSC) and the release toxic contaminants bound in sediments. This impact pathway has, therefore, been scoped into the assessment.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
		Dredge disposal	Yes	Changes in water quality could occur during dredged material disposal through the deposition of material causing elevated SSC and contaminant levels. This could potentially impact on benthic habitats and species. This impact pathway has, therefore, been scoped into the assessment.
	Underwater noise	Piling	Yes	Underwater noise generated by piling has the potential to affect benthic species. This will require assessment and has, therefore, been scoped in.
		Capital dredge	Yes	Underwater noise generated by dredging has the potential to affect benthic species. This will require assessment and has, therefore, been scoped in.
		Dredge disposal	Yes	Underwater noise generated by the movement of the dredger to and from the disposal site has the potential to affect benthic species if this disposal option is adopted. This will require assessment and has, therefore, been scoped in.
	The potential introduction and spread of non-native species	Construction of marine infrastructure	Yes	Non-native species have the potential to be transported into the local area as a result of construction activity. This impact pathway has, therefore, been scoped into the assessment.
		Capital dredge	Yes	Non-native species have the potential to be transported into the local area on the hulls of dredging vessels. Non-native invasive species also have the potential to be transported via vessel ballast water. This impact pathway has, therefore, been scoped into the assessment.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
		Dredge disposal	Yes	Non-native species have the potential to be transported into the local area on the hulls of dredging vessels. Non-native invasive species also have the potential to be transported via vessel ballast water. This impact pathway has, therefore, been scoped into the assessment.
Fish	Direct loss or changes to fish populations and habitat	Piling	No	There is the potential for impacts to fish as a result of habitat loss due to installation of piles and the footprint of the proposed development. However, the direct footprint of the piling only covers a highly localised area with the mobile nature of fish allowing them to utilise nearby areas. This impact pathway has, therefore, been scoped out of the assessment.
		Capital dredge	Yes	Dredging by trailer suction hopper dredger has the potential to result in the direct uptake of fish and fish eggs by the action of the draghead (entrainment). Backhoe dredging can also directly remove fish and fish eggs in the bucket. In addition, capital dredging has the potential to result in seabed disturbance and smothering of seabed habitats and species. These changes have the potential to impact on fish species through potential changes in prey resources and the quality of foraging, nursery and spawning habitats. This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	Yes	Disposal at the marine disposal site will result in the deposition of sediments which has the potential to cause physical disturbance and smothering of seabed habitats. These changes have the potential to impact on fish species through potential changes in prey resources and the quality of foraging, nursery and

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				spawning habitats. This impact pathway has, therefore, been scoped into the assessment.
	Indirect changes to seabed habitats for fish	Piling	No	Piling has the potential to result in changes to hydrodynamic and sedimentary processes (e.g., water levels, flow rates, changes to tidal prism, accretion and erosion patterns). However, such effects will be negligible and highly localised and will cause no direct changes to fish habitat. This impact pathway has, therefore, been scoped out of the assessment.
		Capital dredge	No	The capital dredge has the potential to result in changes to hydrodynamic and sedimentary processes (e.g., water levels, flow rates, changes to tidal prism, accretion and erosion patterns). However, as described in more detail in the Physical Processes assessment (Chapter 7 of this ES), negligible changes in estuary processes are predicted. The predicted changes are not expected to modify existing subtidal habitat types found in the area. Indirect effects on fish habitats (feeding, spawning and nursery areas) are, therefore, considered to be negligible. On this basis, this pathway has been scoped out of the assessment.
		Dredge disposal	No	Dredge disposal has the potential to result in changes to hydrodynamic and sedimentary processes (e.g., water levels, flow rates, changes to tidal prism, accretion and erosion patterns). However, as described in more detail in the Physical Processes assessment (Chapter 7 of this ES), only minor changes in flow rates and subtidal seabed morphology are predicted which are not expected to modify existing subtidal habitat types found in the area (i.e. mobile sand habitats characterised by

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				an impoverished infaunal assemblage). Given the offshore location of the disposal site, no changes in wave regime are predicted. Indirect effects on fish habitats (feeding, spawning and nursery areas) are, therefore, considered to be negligible. On this basis, this pathway has been scoped out of the assessment.
	Changes in water and sediment quality	Piling	No	The expected highly localised and temporary changes in suspended sediment levels (described in more detail in the Physical Processes assessment in Chapter 7 of this ES) and related changes in sediment bound contaminants and dissolved oxygen (described in more detail in the Water and Sediment Quality assessment in Chapter 8 of this ES) associated with bed disturbance during piling are considered highly unlikely to produce adverse effects in any fish species. The potential for accidental spillages will also be negligible during construction through following established industry guidance and protocols. This impact pathway has, therefore, been scoped out of the assessment.
		Capital dredge	Yes	Changes in water quality during capital dredging could impact fish species through an increase in SSC and the release of toxic contaminants bound in sediments. This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	Yes	Changes in water quality could occur during dredged material disposal through the deposition of material causing elevated SSC and contaminant levels. This could potentially impact on fish species. This impact pathway has, therefore, been scoped into the assessment.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
	Underwater noise	Piling	Yes	During piling, there is the potential for noise disturbance to fish. Percussive (impact) and vibro piling will produce underwater noise above background conditions and at a level that may cause a risk of injury and behavioural changes to fish in the vicinity of the proposed development. This impact pathway has, therefore, been scoped into the assessment.
		Capital dredge	Yes	Elevated underwater noise and vibration levels caused by the action of the dredger could potentially affect fish. This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	Yes	Underwater noise and vibration levels caused by the movement of the dredger to and from the disposal site could potentially affect fish. This impact pathway has, therefore, been scoped into the assessment.
Marine mammals	Direct loss or changes in marine mammal foraging habitat	Construction (piling, capital dredge and dredge disposal)	No	There is the potential for impacts to marine mammals as a result of changes to marine mammal foraging habitat and prey resources. However, the footprint of the proposed development only covers a highly localised area that constitutes a negligible fraction of the known ranges of local marine mammal populations. This impact pathway has, therefore, been scoped out of the assessment.
	Changes in water and sediment quality	Piling	No	The negligible, highly localised and temporary changes in suspended sediment levels (described in more detail in the Physical Processes assessment in Chapter 7 of this ES) and related changes in sediment bound contaminants and dissolved oxygen (described in more detail in the Water and Sediment Quality assessment in Chapter 8 of this ES) associated with bed disturbance

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				during piling is considered highly unlikely to produce adverse effects in any marine mammal species. The potential for accidental spillages will also be negligible during construction through following established industry guidance and protocols. This impact pathway has, therefore, been scoped out of the assessment.
		Capital dredge	No	The plumes resulting from dredging are expected to have a relatively minimal and local effect on SSC in the vicinity of the proposed development (see Physical Processes assessment in Chapter 7 of this ES). Marine mammals are well adapted to turbid conditions and, therefore, not sensitive to the scale of changes in SSC predicted during capital dredging (Todd *et al.*, 2015). The extent of sediment dispersal is not expected to cause significant elevations in water column contamination (Chapter 8 of this ES). In addition, the temporary and localised changes in water column contamination levels are considered unlikely to produce any lethal and sub-lethal effects in these highly mobile species (the concentrations required to produce these effects are generally acquired through long-term, chronic exposure to prey species in which contaminants have bioaccumulated) (Todd *et al.*, 2015). Furthermore, the potential for accidental spillages will also be negligible during all phases through the application of established industry guidance and protocols. The potential for water quality impacts to marine mammals has, therefore, been scoped out of the assessment.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
		Dredge disposal	No	The plumes resulting from dredge disposal are expected to have a relatively minimal and local effect on SSC (described in more detail in the Physical Processes assessment in Chapter 7 of this ES). Marine mammals are well adapted to turbid conditions and, therefore, not sensitive to the scale of changes in SSC predicted during disposal (Todd *et al.*, 2015). The extent of sediment dispersal is not expected to cause significant elevations in water column contamination (described in more detail in the Water and Sediment Quality assessment in Chapter 8 of this ES). In addition, the temporary and localised changes in water column contamination levels are considered unlikely to produce any lethal and sub-lethal effects in these highly mobile species (the concentrations required to produce these effects are generally acquired through long-term, chronic exposure to prey species in which contaminants have bioaccumulated) (Todd *et al.*, 2015). Furthermore, the potential for accidental spillages will also be negligible during construction through the application of established industry guidance and protocols. The potential for water quality impacts to marine mammal has therefore been scoped out of the assessment.
	Collision risk	Construction, dredging and dredge disposal	No	Vessels involved in construction and dredging/dredge disposal will be mainly stationary or travelling at low speeds (2-6 knots), making the risk of collision very low. Although all types of vessels may collide with marine mammals, it is vessels that are traveling at speeds over 10 knots which are considered to have a higher probability of causing lethal injury (Schoeman *et al.,*

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				2020). Furthermore, the region is already characterised by heavy shipping traffic. The additional movements due to construction activity (including capital dredging) will only constitute a small increase in vessel traffic in the area which will also be temporary in nature. In general, incidents of mortality or injury of marine mammals caused by vessels remain a relatively rare occurrence in UK waters (ABP Research 1999; CSIP, 2020). For example, out of 144 post mortem examinations carried out on cetaceans in 2018, only two (1.4%) were attributed to boat collision with the biggest causes of mortality including starvation and by-catch, although some incidents are likely to remain unreported (CSIP, 2020). In addition, marine mammals foraging within the Humber Estuary region will routinely need to avoid collision with vessels and are, therefore, considered adapted to living in an environment with high levels of vessel activity. This impact pathway has, therefore, been scoped out of the assessment.
	Underwater noise	Piling	Yes	Percussive (impact) and vibro piling will produce underwater noise above background conditions and at a level that may cause a risk of injury and behavioural changes to marine mammals in the vicinity of the proposed development. This impact pathway has, therefore, been scoped into the assessment.
		Capital dredge	Yes	Elevated noise and vibration levels caused by the action of the dredger could potentially affect marine mammals by inducing adverse behavioural reactions. This impact

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				pathway has, therefore, been scoped into the assessment.
		Dredge disposal	Yes	Elevated noise and vibration levels caused by the movement of the dredger to and from the disposal site could potentially affect marine mammals by inducing adverse behavioural reactions. This impact pathway has, therefore, been scoped into the assessment.
	Visual disturbance of hauled out seals	Construction, dredging and dredge disposal	No	The nearest established breeding colony for grey seals is located over 25 km away at Donna Nook. Approximately 10 to 15 grey seals were also observed hauling out on mudflat at Sunk Island (on the north bank of the Humber Estuary) during the project specific benthic surveys as detailed in Appendix 9.1 to this ES. This haul out site is located approximately 4 km north east from the proposed development and around 3-4 km from the dredge disposal sites (including transit routes). No seal haul out sites are known to occur nearer to the proposed development. Seals which are hauled out on land, either resting or breeding, are considered particularly sensitive to visual disturbance (Hoover-Miller *et al*, 2013). The level of response of seals is dependent on a range of factors, such as the species at risk, age, weather conditions and the degree of habituation to the disturbance source. Hauled out seals have been recorded becoming alert to powered craft at distances of up to 800 m although seals generally only disperse into the water at distances <150-200 m (Wilson, 2014; Mathews, *et al*., 2016; Henry and Hammill, 2001; Strong

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				and Morris, 2010). For example, in a study focusing on a colony of grey seals on the South Devon coast, vessels approaching at distances between 5 m and 25 m resulted in over 64% of seals entering the water, but at distances of between 50 m and 100 m only 1% entered the water (Curtin *et al*., 2009). Recent disturbance research has also found no large-scale redistribution of seals after disturbance with most seals returning to the same haul out site within a tidal cycle (Paterson *et al.,* 2019). Based on this evidence, seals hauled out on the intertidal habitats of Sunk Island (located on the opposite bank to the proposed development) are out of the zone of influence of any potential visual disturbance effects as a result of dredging, dredge disposal or construction activity. The potential for disturbance to hauled out seals has, therefore, been scoped out of the assessment.
Coastal waterbirds	Loss or change to coastal waterbird habitat	Piling	Yes	Piling will cause a direct loss of intertidal habitat although this loss will be highly localised and negligible. Nevertheless, given the protection afforded to the mudflat that is utilised by feeding waterbirds in this area, this impact pathway has been scoped into the assessment.
		Capital dredge	Yes	Capital dredging will cause a direct, albeit minimal, loss of intertidal habitat as well as potential changes which could cause changes to the prey resources available for coastal waterbirds. This impact pathway has, therefore, been scoped into the assessment.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
		Dredge disposal	No	Dredge disposal at sea has the potential to cause impacts to seabed habitats which could cause changes to the prey resources available for seabirds and other diving birds. However, the seabed at the disposal sites is highly dynamic and subject to regular physical disturbance as a result of maintenance dredging and strong tidal currents. This is reflected in a highly impoverished subtidal assemblage (Section 9.6 of this chapter) which provides a limited prey resource. This impact pathway has, therefore, been scoped out of the assessment.
	Noise and visual disturbance	Construction activity (including capital dredging)	Yes	During construction, there is the potential for airborne noise and visual disturbance to affect coastal waterbirds. This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	No	During dredge disposal, there is the potential for the dredging vessel to cause noise and visual disturbance. However, the area is subject to high levels of vessel movements as a result of the regular disposal of maintenance dredge arisings and shipping. These areas are also not known to support large populations of diving birds/seabirds. In addition, any potential disturbance stimuli caused by the capital dredge disposal would be highly temporary and localised with any birds that might be temporarily flushed able to return to feeding following cessation of the capital dredge disposal activity. This impact pathway has, therefore, been scoped out of the assessment.

Benthic habitats and species

9.8.10 This section contains an assessment of the potential impacts to benthic ecology receptors as a result of the construction phase of the IERRT project. The following impact pathways have been assessed:

- Direct loss of intertidal habitat as a result of capital dredging and piles (paragraphs 9.8.11 to 9.8.21);
- Direct loss of subtidal habitat as a result of the piles (paragraphs 9.8.22 to 9.8.26);
- Changes to benthic habitats and species as result of the removal of seabed material during dredging (paragraphs 9.8.27 to 9.8.43);
- Changes to habitats and species as a result of sediment deposition during dredging and dredge disposal (paragraphs 9.8.44 to 9.8.57);
- Indirect loss or change to seabed habitats and species as a result of changes to hydrodynamic and sedimentary processes during capital dredging and dredge disposal (paragraphs 9.8.58 to 9.8.72);
- Changes in water and sediment quality during capital dredging and dredge disposal (paragraphs 9.8.73 to 9.8.94);
- Underwater noise and vibration during piling, capital dredging and dredge disposal (paragraphs 9.8.95 to 9.8.102); and
- Introduction and spread of non-native species paragraphs (9.8.103 to 9.8.109).

Direct loss of intertidal habitat as a result of capital dredging and piles

General scientific context

9.8.11 The impact of direct habitat loss can involve building over marine habitats (such as reclamation) or the permanent physical removal of substratum and associated organisms from the seabed. Direct habitat loss can also occur due to deepening as a result of dredging causing a change from an intertidal to a subtidal environment.

9.8.12 Intertidal habitats are sensitive to physical loss at locations where new structures are introduced onto the seabed (i.e., within the development 'footprint' of these structures). The significance of such losses will vary on a site-by-site basis in response to differences in the extent and duration of the losses as well as the relative value of the habitats in question. The value of the habitats is, in turn, reflected by the species that are present and level of statutory and non-statutory protection afforded to them. As any effects are very much dependent upon site specific considerations, a generic scientific review is not appropriate, and the focus of the impact assessment has been based on site-specific considerations.

Project impact assessment

9.8.13 The IERRT development will result in the direct loss of 0.012 ha of intertidal habitat. This direct loss is due to the following:

- Capital dredging which has the potential to cause a direct loss of 0.006 ha of intertidal habitat which will become subtidal habitat as a result of the deepening; and
- Piling, which will cause a direct loss of 0.006 ha of intertidal mudflat habitat.

9.8.14 It should be noted that the potential direct loss of intertidal habitat due to the capital dredge is located on the side slope of the proposed dredge pocket. The existing slope in this area is similar in gradient to the 1 in 4 dredge slope that is proposed for the IERRT project (see Chapter 2 and Chapter 3 of this ES). Furthermore, the amount of material that needs to be dredged within the berth pocket in this location is limited. It is, therefore, anticipated that the existing slope will remain stable and will not require further dredging to maintain navigational safety, resulting in no direct habitat loss from the capital dredge. Nevertheless, this assessment accounts for a potential loss of 0.006 ha as a worst case scenario and on a precautionary basis.

9.8.15 Dredging will also cause a direct change in intertidal habitat. This is assessed in more detail in the section that follows entitled '*Changes to benthic habitats and species as result of the removal of seabed material during dredging'*.

9.8.16 The project-specific intertidal benthic survey recorded sandy mud habitat within and near to the proposed dredge footprint characterised by nematodes, the oligochaetes *Tubificoides benedii*, the mud shrimp *Corophium volutator*, the gastropod mudsnail *Peringia ulvae*, tellins including Baltic tellin *Limecola balthica* and the polychaetes *Hediste diversicolor* and *Pygospio elegans*. All the species recorded from the samples in this area were considered commonly occurring in the region and considered typical of the community recorded on mudflats in the nearby area (Appendix 9.1 of this ES; ABPmer, 2009; IECS, 2010; Able UK Limited, 2021). Species such as *Corophium volutator, Peringia ulvae, Limecola balthica* and polychaetes are prey items for a range of coastal waterbirds. The impact of the loss of habitat and prey resources for waterbirds is discussed in greater detail in the sub-section of the assessment covering 'Coastal waterbirds' (paragraph 9.8.207 to 9.8.219).

9.8.17 The Humber SAC covers an area of 36657 ha with the combined worst case intertidal habitat loss as a result of the capital dredge and piling represents approximately 0.000033% the Humber Estuary SAC and approximately 0.000128% of the 'mudflats and sandflats not covered by seawater at low tide' feature of the Humber Estuary SAC[14].

9.8.18 The Humber SPA and Ramsar Cover an area of 37630 ha and 37988 ha respectively. This loss represents 0.000032% of the Humber Estuary SPA/Ramsar[15]. When considering this in the context of intertidal area, the

[14] Based on the extents given in the Standard Data Form on the JNCC website (JNCC, 2022a)
[15] Based on the extents given in the Standard Data Form on the JNCC website (JNCC, 2022b)

area of loss represents approximately 0.000135% of intertidal foreshore habitats[16] and approximately 0.000188% of mudflat[17] within the SPA.

9.8.19 This habitat loss is, therefore, negligible in the context of the Humber Estuary SAC, SPA and Ramsar.

9.8.20 Furthermore, the potential intertidal loss resulting from the capital dredging (noting that this is considered a worst case as explained above) would consist of only a very narrow strip on the lower shore around the sublittoral fringe (see Figure 2.1 to this ES). This potential loss is considered to be of a similar scale to that which can occur due to natural background changes in mudflat extent in the local region (e.g., due to seasonal patterns in accretion and erosion or following storm events. As noted above, the loss of habitat due to piling will in addition be highly localised and it is considered, negligible. These *de minimis* changes in mudflat extent are of a magnitude which will not change the overall structure or functioning of the nearby mudflats within the Port of Immingham area or more widely in the Humber Estuary.

9.8.21 Based on the evidence provided above, the probability of habitat loss occurring is high and the magnitude of potential impacts is considered to be negligible. Exposure to change is, therefore, negligible. While the sensitivity of species to direct habitat loss, is considered to be high for all benthic habitats and species within the footprint (given the lack of recoverability), vulnerability is assessed as none. While the benthic community is common throughout the region, it is noted that the intertidal habitat itself is protected (both a qualifying feature of the Humber Estuary SAC and a NERC Habitat of Principle Importance) and of functional importance for waterbirds. On this basis ,whilst importance is considered to be high, taking all of these factors into account, the potential effects arising from the direct loss of intertidal are considered to be **insignificant**.

Direct loss of subtidal habitat as a result of the piles

General scientific context

9.8.22 The impact of direct habitat loss can involve building over marine habitats (such as reclamation) or the permanent physical removal of substratum and associated organisms from the seabed. Direct habitat loss can also occur due to deepening as a result of dredging causing a change from an intertidal to a subtidal environment.

9.8.23 Subtidal habitats are sensitive to physical loss at locations where new structures are introduced onto the seabed (i.e., within the development 'footprint' of these structures). The significance of such losses will vary on a

[16] Based on using the 'Intertidal Substrate Foreshore (England and Scotland)' data layer (https://magic.defra.gov.uk/Metadata_for_MAGIC/SPIRE%20intertidal%20substrate%20foreshore.pdf

[17] Based on using mudflat data layer of the Priority Habitat Inventory (England) (https://data.gov.uk/dataset/4b6ddab7-6c0f-4407-946e-d6499f19fcde/priority-habitat-inventory-england).

site-by-site basis in response to differences in the extent and duration of the losses as well as the relative value of the habitats in question. The value of the habitats is, in turn, reflected by the species that are present and level of statutory and non-statutory protection afforded to them. As any effects are very much dependent upon site specific considerations, a generic scientific review is not appropriate in this case and the focus of the impact assessment is based on site-specific considerations.

Project impact assessment

9.8.24 Piling in the subtidal area will result in the direct loss of 0.027 ha of seabed habitat. This habitat represents approximately 0.000074% of the Humber Estuary SAC. However, a small amount of subtidal habitat will potentially be gained following the dredging of the existing intertidal (described above at paragraphs 9.8.13 to 9.8.21).

9.8.25 The project-specific subtidal survey (Section 9.6 of this chapter and Appendix 9.1 of this ES) recorded a benthic community characterised by nematodes, the mudshrimp *Corophium volutator,* polychaetes (such as *Streblospio shrubsolii Polydora cornuta Tharyx spp and Nephtys spp.*), oligochaetes *Tubificoides spp.* and barnacle *Amphibalanus improvises*. These characterising species dominated the assemblage and contributed almost entirely to the total abundances of organisms recorded at most of the sample stations. The loss in subtidal habitat as a result of the piles is considered negligible in the context of extent of the overall amount of similar marine habitats found locally in the Humber Estuary. All the species recorded were considered commonly occurring and not protected. Furthermore, faunal assemblage recorded are also considered characteristic of subtidal habitats found more widely in this section of the Humber Estuary (ABPmer, 2009; IECS, 2010; Able UK Limited, 2021).

9.8.26 On this basis, the magnitude of the impact is considered to be negligible. Sensitivity is considered to be high for all benthic habitats and species within the footprint (given the lack of recoverability following piling). Importance is considered to be moderate as the subtidal species found in the area are commonly occurring and of low conservation concern although subtidal habitats form a component of the 'Estuaries' feature of the SAC. On this basis, the effect resulting from direct habitat loss on benthic habitats and species is assessed as **insignificant**.

Changes to benthic habitats and species as result of the removal of seabed material during dredging

General scientific context

9.8.27 Dredging causes a direct physical removal of sediments, causing a modification to the existing subtidal and intertidal habitats. The impacts to benthic fauna associated with the dredged material include changes to abundance and distribution through damage, mortality or relocation to a disposal site.

9.8.28 The speed of recovery of the temporarily disturbed areas is dependent on the scale and timing of the disturbance, the life histories of species and the stability and diversity of the benthic community present. For example, while the opportunistic bivalve *Abra* spp. is vulnerable to physical disturbance (due to its fragile shell), the species is considered to have a high recoverability due to a high fecundity and larval dispersal rate (Marine Ecological Surveys Limited, 2008; De-Bastos, 2016a). Furthermore, a regularly disturbed sedimentary habitat with a low diversity benthic assemblage is likely to recover more quickly (i.e., return to its disturbed or 'environmentally-stressed' baseline condition) than a stable habitat with a pre-existing mature and diverse assemblage (Johnson *et al.,* 2017).

9.8.29 In general, where studies have been undertaken to understand the effects of physical disturbance, they have shown recolonisation of deposited sediments by benthic species to be quite rapid. Sites are initially colonised by short lived, fast growing, opportunistic species ('r-selected') that are tolerant of high levels of disturbance; infaunal species dominate, particularly polychaetes worms. In time, these are succeeded by longer lived, slower growing species with a lower tolerance for disturbance (Newell *et al.,* 1998; Tillin *et al.,* 2011). Rates of recovery reported in reviewed literature suggest that a recovery time of six to 24 months is characteristic of many mobile sands and estuarine muds where frequent disturbance of the deposits precludes the establishment of long-lived communities (Tillin *et al*., 2019; De-Bastos, 2016b). In contrast, a community of sands and gravels may take two to three years to establish, depending on the proportion of sand and level of environmental disturbance by waves and currents (Newell *et al.,* 1998; Bolam *et al.,* 2003).

Project impact assessment

9.8.30 The capital dredge will remove approximately 190,000 m³ of material over a maximum area of approximately 70,000 m² (see Chapter 2, Section 2.3 of this ES). It is expected that the majority or all of the material will be removed with a backhoe dredger, although some material may also be removed by trailer suction hopper dredger (TSHD).

9.8.31 The dredging will lead to changes to 6.8 ha of subtidal habitat as a direct result of the physical removal of subtidal sediment, as well as a change over 0.003 ha of intertidal which will become lower in elevation (but remain intertidal) due to the dredging of the slope of the dredge pocket. These habitat changes are assessed in this section.

Changes to subtidal habitats and species

9.8.32 Following the capital dredge, the dredge pockets will provide a similar habitat to that occurring under pre-dredge conditions as a result of sediment deposition. The baseline benthic surveys predominantly recorded surface sediment within and near to the dredge footprints with a high silt content (i.e., mud and sandy mud) (Section 9.6 and Appendix 9.1 of this ES). Modelling predicts that accretion of silt in the order of 10-15 cm would be expected to occur within a matter of months within the dredge footprint (as summarised in the Physical Processes assessment (Chapter 7 of this ES).

This would provide a suitable depth for colonisation[18] and return the surface layer of the seabed in the dredge footprint to its existing sediment character (i.e., fine sediment with a high silt content) which would then be expected to be recolonised by a similar assemblage to baseline conditions.

9.8.33 The speed of recolonisation is expected to occur over a relatively short period of time based on an understanding of the benthic community present in the area and the life history strategies of the species. The project-specific subtidal survey (Section 9.6 of this chapter and Appendix 9.1 of this ES) recorded a generally impoverished benthic community which is likely to reflect the existing high levels of physical disturbance in the area due to strong tidal currents and sediment movement.

9.8.34 Samples were characterised by nematodes, the mudshrimp *Corophium volutator,* polychaetes (such as *Streblospio shrubsolii Polydora cornuta Tharyx spp and Nephtys spp.*), oligochaetes *Tubificoides spp.* and barnacle *Amphibalanus improvises.* These characterising species dominated the assemblage and contributed almost entirely to the total abundances of organisms recorded at most of the sample stations. These species are typically fast growing and/or have rapid reproductive rates which allow populations to fully re-establish in typically less than 1-2 years and for some species within a few months (De-Bastos and Hill, 2016; De-Bastos and Hiscock, 2016; Tillin, 2016; Ashley, 2016). The benthic communities would, therefore, be expected to recolonise the dredge footprint relatively quickly. All the species recorded are commonly occurring and not protected. In addition, the faunal assemblage recorded is considered characteristic of subtidal habitats found more widely in this section of the Humber Estuary (ABPmer, 2009; IECS, 2010; Able UK Limited, 2021). Subtidal habitats in area around the Port of Immingham are considered to be typically of limited ecological value.

9.8.35 It should be noted that this assessment specifically relates to the effects of the capital dredge. The frequency of dredging required as part of maintenance dredging, however, will mean that the seabed in the berths is likely to be disturbed on a regular basis once the proposed development is operational. Changes to benthic habitats and species as result of the removal of seabed material during maintenance dredging is assessed in paragraphs 9.8.256 to 9.8.261.

Changes to intertidal habitats and species

9.8.36 A very small area of lower shore intertidal habitat at the top edge of the dredge slope will become steepened and slightly lower in the tidal frame as a result of the dredging (0.003 ha). The habitat will, however, remain intertidal mudflat.

9.8.37 As noted above for the impact pathway on '*Direct loss of intertidal habitat as a result of capital dredging and piles*', it is anticipated that the existing slope will remain stable and will not require further dredging to maintain

[18] The majority of marine infauna is known to occur in the upper few centimetres of sediment (Kingston, 2001; Reuscher *et al.,* 2019).

navigational safety. This will, therefore, result in no direct change to intertidal habitat from the capital dredge. Nevertheless, this assessment accounts for a 0.003 ha change calculated on a worst case and precautionary basis.

9.8.38 The habitat change represents approximately 0.000055% of the Humber Estuary SAC and approximately 0.000213% of the 'mudflats and sandflats not covered by seawater at low tide' feature of the Humber Estuary SAC[19].

9.8.39 It should be noted that habitat change at this de minimis scale is in the range of local natural variability and is expected to be immeasurable in real terms when taking account of the variation in water levels, wave climate and accuracy of the modelled bathymetry.

9.8.40 The speed of recolonisation following dredging is expected to occur over a relatively short period of time based on an understanding of the benthic community present in the area and the life history strategies of the species. The project-specific intertidal survey (Section 9.6 of this chapter and Appendix 9.1 of this ES) recorded a benthic community characterised by nematodes, the oligochaetes *Tubificoides benedii* and *Enchytraeidae* spp., the mud shrimp *Corophium volutator*, the gastropod mudsnail *Peringia ulvae*, Baltic tellin *Limecola balthica* and the polychaetes *Hediste diversicolor* and *Pygospio elegans*. All the species recorded within the site specific intertidal benthic survey in the local area are commonly occurring. These species are also typically fast growing and/or have rapid reproductive rates which allow populations to fully re-establish in typically less than 1-2 years and for some species within a few months (Ashley and Budd, 2020; Tillin and Rayment, 2016). The benthic communities are, therefore, expected to recolonise this area of intertidal change relatively rapidly.

9.8.41 While the lowering could result in some localised changes to infaunal composition, the key commonly recorded species recorded on the foreshore in the project-specific surveys are found at a range of shore heights from the sublittoral fringe to the upper shore and are considered relatively tolerant to changes in emergence which do not alter the extent of the intertidal (Ashley and Budd, 2020; Tillin and Rayment, 2016). Therefore, characterising species and ecological structure will be similar to baseline condition. On this basis, there is no reason to suggest that this lower elevation mudflat will be ecologically poorer or provide a lower functionality.

9.8.42 Based on the evidence provided above in the scientific review and applying the project impact assessment methodology:

- the magnitude of the change to the subtidal habitats and associated benthic species is considered to be small; whilst
- The magnitude of change to intertidal habitats is negligible.

[19] Based on the extents given in the Standard Data Form on the JNCC website (JNCC, 2022a).

9.8.43 Therefore, while the probability of occurrence is high, the overall exposure is assessed as low for subtidal habitats and negligible for intertidal habitats. The sensitivity of intertidal and subtidal habitats to seabed disturbance within the dredge footprint is considered to be low given the high recoverability rates. Vulnerability is, therefore, assessed as low for subtidal habitats, and none for intertidal habitats. While both the subtidal and intertidal benthic communities are considered commonly occurring in the region, subtidal habitats form a component of the 'Estuaries' feature of the SAC. Intertidal habitats are protected (both a qualifying feature of the Humber Estuary SAC and a NERC Habitat of Principle Importance) and of functional importance for waterbirds. Importance is, therefore, considered to range from moderate (for subtidal habitats) to high (for intertidal habitats). Overall, however, the potential effect is assessed as **insignificant to minor** for subtidal habitats and **insignificant** for intertidal habitats.

Changes to habitats and species as a result of sediment deposition during dredging and dredge disposal

General scientific context

9.8.44 Sediments suspended and dispersed during the marine works, dredging and disposal have the potential to resettle over the seabed. This potential blanketing or smothering of benthic species may cause stress, reduced rates of growth or reproduction and in the worst cases the effects may be fatal (Pineda *et al.,* 2017; Bolam *et al*., 2016).

9.8.45 Habitats within estuarine and coastal environments have highly fluctuating conditions including the resuspension and deposition of sediments on a daily basis (through tidal action), lunar cycles (due to the differing influences of spring and neap tides) and on a seasonal basis (due to storm activity and conditions of extreme waves). Subtidal and intertidal habitats are, therefore, characterised by such perturbations and the biological communities of these environments are well adapted to survival under fluctuating conditions.

9.8.46 If the amount of sediment deposited is too great to allow species to survive burial, then recovery occurs via re-colonisation and/or migration to the new sediment surface (Bolam *et al.,* 2006a; 2006b). In general, the rate of recovery is dependent upon just how stable and diverse the assemblage was in the first place. A regularly disturbed sedimentary habitat with a low diversity benthic assemblage is likely to recover more quickly (i.e., return to its disturbed or 'environmentally-stressed' baseline condition) than a stable habitat with a pre-existing mature and diverse assemblage. A study by Bolam *et al.* (2004), for instance, concluded that the relatively rapid recovery observed at a location on the Crouch Estuary was due to the opportunistic nature of the invertebrate assemblages and the dispersive behaviour of the dominant species that were present before the material was deposited. Furthermore, in cases where the quantity and type of sediment deposited does not differ greatly from natural sedimentation, e.g., of similar particle size, the effects are likely to be relatively small as many of the species are capable of migrating up through the deposited sediments (Budd, 2004).

9.8.47 The Marine Evidence based Sensitivity Assessment (MarESA) approach (Tyler-Walters *et al.,* 2018) found that benthic communities in both sandy and muddy estuarine sediments are typically considered to be tolerant to the deposition of up to 5 cm of fine material in a single event with burrowing species considered able to relocate to preferred depths through this level of deposition. Deposition of greater depths of fine sediment could result in some mortality although evidence suggests that some characterising species are likely to be able to reposition. Bivalve and polychaete species have been reported to migrate through depositions of sediment greater than 30 cm (De-Bastos, 2016a; De-Bastos, 2016b; Ashley, 2016; Tillin, 2016). A previous review by the University of Hull also concluded that benthic invertebrates in sediments are able to adapt and readjust if sediment laid is placed as thin veneers over several days although they can also tolerate moderate amounts (20 cm) of material being deposited at one time (IECS, 2001).

Project impact assessment: Capital dredging

9.8.48 Sediment changes that are predicted to occur as a result of the capital dredge are considered in more detail in the Physical Processes assessment (Chapter 7 of this ES). In summary, however, it has been concluded that maximum siltation as a result of the capital dredge within about 100 m up and down the estuary from the edge of the dredge pocket is predicted to be 7 to 8 mm reducing to around 3 mm within approximately 500 m from the dredged pocket. Beyond these areas, deposition levels are predicted to be less than 1 mm. Furthermore, once on the bed, the deposited material will return to the background system i.e., it will be put back into suspension on subsequent peak flood or ebb tides to be further dispersed.

9.8.49 The project-specific intertidal survey (Section 9.6 of this chapter and Appendix 9.1 of this ES) recorded a community characterised by nematodes, the oligochaetes *Tubificoides benedii* and *Enchytraeidae* spp., the mud shrimp *Corophium volutator*, the gastropod mudsnail *Peringia ulvae*, Baltic tellin *Limecola balthica* and the polychaetes *Hediste diversicolor* and *Pygospio elegans*. The subtidal survey generally recorded an impoverished benthic community (which is likely to reflect the existing high levels of physical disturbance in the area due to strong near bed tidal currents, sediment transport and ongoing maintenance dredging) characterised by nematodes, the mudshrimp *Corophium volutator,* polychaetes (such as *Streblospio shrubsolii Polydora cornuta Tharyx spp. and Nephtys spp.*), oligochaetes *Tubificoides spp* and barnacle *Amphibalanus improvises*. These characterising species dominated the assemblage and contributed almost entirely to the total abundances of organisms recorded at most of the sample stations. All the species recorded were considered commonly occurring and not protected.

9.8.50 The benthic species occurring within and near to the dredge area typically consist of burrowing infauna (such as polychaetes, oligochaetes or bivalves), which are considered tolerant to some sediment deposition. The predicted millimetric changes in deposition are, therefore, considered unlikely to cause smothering effects as described above. In addition, the species recorded in the benthic invertebrate surveys are fast growing and/or

have rapid reproductive rates which allow populations to fully re-establish in typically less than 1-2 years and for some species within a few months (Ashley and Budd, 2020; De-Bastos and Hiscock, 2016; Tillin, 2016; Ashley, 2016).

9.8.51 Deposition of sediment as a result of dredging will be highly localised and similar to background variability. Magnitude of change is, therefore, assessed as negligible. Probability of occurrence is high and thus the overall exposure to change is negligible. Based on the evidence provided above, sensitivity of intertidal and subtidal habitats within the vicinity of the proposed works to increased smothering are considered to be low given that these species are well adapted to survival under fluctuating sediment conditions and have high recoverability rates. Vulnerability is therefore assessed as none. While both the subtidal and intertidal benthic communities are considered commonly occurring in the region, subtidal habitats form a component of the 'Estuaries' feature of the SAC. Intertidal habitats are protected (both a qualifying feature of the Humber Estuary SAC and a NERC Habitat of Principle Importance) and of functional importance for waterbirds. Importance is, therefore, considered to range from moderate (for subtidal habitats) to high (for intertidal habitats). The overall potential impact of deposition on benthic features is assessed as **insignificant**.

Project impact assessment: Disposal

9.8.52 The requirement for disposal of dredged material at sea associated with the proposed development would be fulfilled at licensed disposal sites HU056 and HU060 (see Chapters 2 and 3 of this ES).

9.8.53 An assessment of the sediment changes that are predicted to occur as a result of the capital dredging is presented in more detail in the Physical Processes assessment (Chapter 7 of this ES). In summary, sedimentation resulting from the disposal plume is predicted to be generally in the range of 4 to 6 mm at distances of several hundred metres from the disposal sites to within approximately 4 km. Further up and down estuary, maximum sedimentation as a result of the disposal activities is generally predicted to be less than 1 to 2 mm.

9.8.54 The disposal sites are located in the mid channel and are subject to regular natural physical disturbance (and associated scouring) as a result of very strong tidal flows. These disposal sites are also used regularly for the disposal of maintenance dredge arisings (for example millions of wet tonnes of dredge sediment are disposed of at HU060 annually) which will also cause some disturbance due to sediment deposition. This is reflected in a generally impoverished assemblage at both disposal sites.

9.8.55 The benthic species recorded within and adjacent to the disposal sites include mobile infauna (such as errant polychaetes e.g., *Arenicola* spp. and amphipods) which are able to burrow through sediment. They are, therefore, considered tolerant to some sediment deposition. In addition, characterising species typically have opportunistic life history strategies, with short life histories (typically two years or less), rapid maturation and the production of large numbers of small propagules which makes them capable

of rapid recoverability should mortality as a result of smothering occur (Ashley and Budd, 2020; De-Bastos and Hiscock, 2016; Tillin, 2016; Ashley, 2016; Tyler-Walters and Garrard, 2019). On this basis, any effects are considered to be temporary and short term.

9.8.56 In summary, deposition in the wider area surrounding the disposal ground is expected to be in the order of millimetres based on the Physical Processes assessment (Chapter 7 of this ES). Sedimentation of this scale is unlikely to result in significant smothering effects to most faunal species with recoverability expected to be high.

9.8.57 The magnitude of the change during disposal is considered to be negligible. Probability of occurrence is high, and the overall exposure is, therefore, negligible. Given that habitats and species within and around the disposal site are well adapted to disturbed conditions with high recoverability rates, sensitivity is considered to be low and thus vulnerability is considered to be none. The benthic habitats and associated species that overlap with the changes brought about during disposal are of low ecological value but characteristic of the 'Sandbanks which are slightly covered by sea water all the time' feature of the Humber Estuary SAC. Therefore, importance is assessed as high. The overall potential impact of deposition on benthic features is assessed as **insignificant.**

Indirect loss or change to seabed habitats and species as a result of changes to hydrodynamic and sedimentary processes

General scientific context

9.8.58 Port or harbour structures (such as piles, breakwaters, coastal defences, jetties or quay walls) can cause changes to hydrodynamics (flow speeds, flow direction, waves, water levels) and seabed morphology (Prumm and Iglesis, 2016; Mohanty *et al*., 2012; Kudale, 2010). Such changes have the potential to affect habitat quality and result in changes to the diversity, abundance and biomass of intertidal and subtidal species.

9.8.59 Dredging can cause direct habitat changes resulting from seabed removal and sediment deposition, as well as indirect habitat changes linked to hydrodynamic and sedimentary processes. Deepening or widening of channels during dredging can change seabed bathymetry and potentially alter flow patterns (speed/direction), wave exposure and cause tidal amplification (Van Dijk *et al*., 2019; Bradbury *et al*., 2003; Cox *et al.,* 2003).

9.8.60 These hydrodynamic changes can lead to changes in sediment transport and also patterns of emersion/immersion as well as erosion/accretion of marine sedimentary habitats such as mudflats and sandbanks (Van Dijk *et al.,* 2019). For example, Cox *et al.* (2003) found that saltmarsh retreat was related to an increase in the tidal prism brought about by dredging operations to maintain or increase the depth of the main navigable channel of the Westerschelde Estuary in the Netherlands. The consequent greater frequency with which the high tides reached the edge of the fringing marshes increased the risk of erosion.

9.8.61 Increased flow rates can also increase scouring and bed disturbance of subtidal habitats which can cause a reduction in diversity and an increase in more opportunistic species. Reductions in water flow could also increase siltation levels which could change the habitat type of a seabed and lead to sedimentation (Ashley and Budd, 2020). Marine invertebrates inhabiting sand and mud habitat show different tolerance ranges of physiological stresses caused by exposure and tidal elevation. This can lead to zonation (Peterson, 1991). Bathymetric changes caused by dredging could, therefore, change the vertical distribution of marine habitats if post-dredging water depths were outside the range at which specific biotopes exist.

Project impact assessment: Marine works

9.8.62 An assessment of the hydrodynamic and sediment regime changes that are predicted to occur as a result of the marine works are considered in more detail in the Physical Processes assessment (Chapter 7 of this ES). It should be noted that predicted changes are primarily as a result of the capital dredging with the effects due to the presence of the piles having a negligible, localised effect.

9.8.63 Slight increases to local peak ebb current speed landward of the berth pocket are predicted to cause a limited amount of erosion of the bed along part of the lower intertidal (at the elevation of MLWS) beneath the landward ends of the proposed jetty (Figure 7.18 of this ES). This will result in a potential indirect loss in intertidal area (approximately 0.01 ha). The assessment indicates that once the softer upper layer is removed, the harder, more consolidated, underlayer of bed material is unlikely to erode further. This calculation represents a worst-case assessment of potential elevation changes and has been considered on a precautionary basis. The level of predicted change is at the limit of the accuracy of the modelled data and, in real terms, is likely to be immeasurable against the context of natural variability (as a result of storm events, for example).

9.8.64 The combined intertidal habitat loss as a result of the capital dredge and piling represents approximately 0.000027% the Humber Estuary SAC and approximately 0.000107% of the 'mudflats and sandflats not covered by seawater at low tide' feature of the Humber Estuary SAC[20].

9.8.65 This loss also represents 0.000027% of the Humber Estuary SPA/Ramsar[21]. When considering this in the context of intertidal area, the area of loss represents approximately 0.000113% of intertidal foreshore habitats[22] and approximately 0.000157% of mudflat[23] within the SPA.

[20] Based on the extents given in the Standard Data Form on the JNCC website (JNCC, 2022a)
[21] Based on the extents given in the Standard Data Form on the JNCC website (JNCC, 2022b)
[22] Based on using the 'Intertidal Substrate Foreshore (England and Scotland)' data layer (https://magic.defra.gov.uk/Metadata_for_MAGIC/SPIRE%20intertidal%20substrate%20foreshore.pdf
[23] Based on using mudflat data layer of the Priority Habitat Inventory (England) (https://data.gov.uk/dataset/4b6ddab7-6c0f-4407-946e-d6499f19fcde/priority-habitat-inventory-england).

9.8.66 The predicted intertidal loss, albeit assessed on a worst case basis, also consists of a very narrow strip on the lower shore around the sublittoral fringe. This predicted loss would be of a similar scale to that which can occur due to natural background changes in mudflat extent in the local region (e.g., due to seasonal patterns in accretion and erosion or following storm events). It is not considered that this *de minimis* change in mudflat extent will change the overall structure or functioning of the nearby mudflats within the Port of Immingham area or more widely in the Humber Estuary.

9.8.67 Based on these factors, the magnitude of change on marine habitats and species from these highly localised and small scale predicted effects due to hydrodynamic and sedimentary processes is considered to be negligible. Although the probability of occurrence is high the overall exposure is consequently assessed as negligible. While both the subtidal and intertidal benthic communities are considered commonly occurring in the region, subtidal habitats form a component of the 'Estuaries' feature of the SAC. Intertidal habitats are protected (both a qualifying feature of the Humber Estuary SAC and a NERC Habitat of Principle Importance) and of functional importance for waterbirds. Importance is, therefore, considered to range from moderate (for subtidal habitats) to high (for intertidal habitats). The impact is therefore considered to be **insignificant.**

Project impact assessment: Disposal

9.8.68 An assessment of the hydrodynamic and sediment regime changes that are predicted to occur as a result of the disposal are considered in more detail in the Physical Processes assessment (Chapter 7 of this ES).

9.8.69 Local changes to the bathymetry (as a result of material disposal to the bed) within the disposal site will be small in the context of the existing depths. Disposal activity will be targeted to the deeper areas within the site, ensuring that bed level changes are not excessive in any one area, thus, minimising the overall change. As a result, associated changes to the local hydrodynamics (and sediment transport pathways) will be negligible.

9.8.70 These changes are not likely to result in any significant changes to local sediment transport in the region although some localised changes to seabed bathymetry and morphology could occur.

9.8.71 In addition, the predicted changes in flow rates and subtidal seabed morphology are not expected to modify existing subtidal habitat types found in the area (i.e. mobile sand habitats characterised by an impoverished infaunal assemblage).

9.8.72 In light of the above, it is concluded that the magnitude of change on marine habitats and species from these highly localised and small scale predicted effects on the hydrodynamic and sedimentary processes is considered to be negligible. Although the probability of occurrence is high the overall exposure is assessed as negligible. The marine habitats which will be potentially affected are considered to be tolerant to the level of change in conditions expected and, therefore, sensitivity is assessed as low, and vulnerability is assessed as none. The benthic habitats and associated

species that overlap with the changes brought about during disposal are of low ecological value but considered characteristic of the 'Sandbanks which are slightly covered by sea water all the time' feature of the Humber Estuary SAC. As a consequence, importance is assessed as moderate. The overall impact is, therefore, assessed as **insignificant**.

Changes in water and sediment quality during dredging and dredge disposal

General scientific context

Elevated suspended sediment concentrations

9.8.73 Dredging activities result in the suspension of disturbed sediment (Newell *et al.,* 1998). Macrofauna living in estuarine systems which are subject to naturally high levels of SSCs are considered well adapted to living in highly turbid conditions. An increased level of suspended sediments may result in an increase in food availability and therefore growth and reproduction for surface deposit feeders (such as certain polychaetes) within estuarine environments that rely on a supply of nutrients at the sediment surface. However, food availability would only increase if the additional suspended sediment contained a significant proportion of organic matter, and the population would only be enhanced if food was previously limiting (De-Bastos, 2016b).

9.8.74 Greater energetic costs for benthic species could occur as a result of higher particle loads due to elevated suspended sediments stimulating the secretion of mucus to protect branchial or feeding structures of filter feeding organisms (Perry, 2016). Suspended sediment concentrations have been found to have a negative linear relationship with sub-surface light attenuation. Light availability and water turbidity are principal factors in determining depth range at which kelp and other algae are recorded. In addition, certain mobile epistrate feeders (such as the amphipod *Bathyporeia* spp.) feed on diatoms within the sand grains and an increase in suspended solids that consequently reduced light penetration could alter food supply (Tillin *et al*., 2019). However, longer-term changes in turbidity levels rather than temporary elevations are likely to be required to elicit any measurable changes in these species.

9.8.75 Elevated suspended sediment levels can also cause increased scouring and damage of epifaunal species due to the potentially abrasive action of the suspended sediment in flowing water.

9.8.76 Increased suspended sediments may favour the development of suspension feeders such as bivalves over other species. However, it should be noted that many benthic invertebrates can switch feeding modes depending on environmental conditions. The negative effects of suspended sediment may be particularly important during larval settlement in spring, with settling stages potentially being more sensitive to effects such as scour. However, this is generally thought to be of less concern where fauna are adapted to naturally high levels of suspended sediments (Boyd *et al*., 2004).

Dissolved oxygen

9.8.77 The resuspension of sediments containing organic material can cause oxygen depletion within the water column and the subsequent settling of this organic rich sediment can deplete sediment oxygen levels, potentially affecting benthic species. Reductions in dissolved oxygen from suspended sediments as a result of dredging are generally considered to be minimal and short-lived. However, potential effects can be more pronounced if dredging causes the disturbance of high levels of oxygen-depleting substances and nutrients present in some very fine-grained sediment deposits and where a great portion originate form waste water (Cefas, 2012).

9.8.78 Oxygen depletion in severe situations can lead to hypoxia with most research on the effects of reductions in dissolved oxygen on benthic fauna during hypoxic conditions. This occurs when oxygen is consumed (e.g., by decomposing organic matter, respiration and oxidation of reduced chemical species) faster than it is replenished (e.g., via air-water oxygen transfer, photosynthesis, and mixing) (Larsen *et al*., 2019). Coastal and estuarine waters can be particularly susceptible to low oxygen conditions as sediments are organic-rich and impose high sediment oxygen demands. Highly stratified estuaries, in which surface and bottom waters do not mix, are more prone to hypoxia (Larsen *et al*., 2019). Coastal areas are more likely to experience hypoxia during summer when high temperatures strengthen salinity stratification (Levin *et al*., 2009). Severe anoxic events can deplete the benthic invertebrate communities and cause a shift in community composition, through attrition of intolerant species and elevated dominance, as well as reductions in body size (Tweedley *et al*., 2015). In general, crustaceans and echinoderms are typically more sensitive to hypoxia, with lower oxygen thresholds, than annelids, molluscs and cnidarians (Levin *et al*., 2009).

Release of contaminants

9.8.79 Benthic habitats and species are sensitive to toxic contamination (where concentrations of contaminants exceed sensitivity thresholds). Toxic contamination during construction can occur as a result of the release of synthetic contaminants such as fuels and oils or through the resuspension of sediment as a result of the disturbance of the seabed which can lead to the release and mobilisation of sediment-bound contaminants into the water column. These include both toxic contaminants, such as heavy metals, pesticides and hydrocarbons, and non-toxic contaminants, such as nutrients. In particular, there is a risk that any uncontrolled releases of materials or sediments into the water column could make contaminants temporarily available for uptake by marine organisms. Over the longer-term any such releases could also become stored in the surface sediments of benthic habitats for future benthic uptake.

9.8.80 Suspension-feeding organisms may be particularly vulnerable to pollutants in the water column due to their dependence on filtration (Tillin *et al*., 2019). High levels of chemical contaminants can potentially cause genetic, reproductive and morphological disorders in marine species. Contaminants

may also have combined effects. Studies have suggested links between contamination with polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyl (PCBs), amines and metals and a range of disorders (MacDonald and Ingersoll, 2010). Increased incidence of tumours, neoplasia, DNA damage, polyploidy, hypoploidy, hermaphoditism and reduced immune response have all been reported in marine invertebrates in areas of high levels of pollution (Hannam *et al.,* 2010; Catalano *et al.,* 2012; Hesselman *et al.,* 1988; Nacci and Jackim, 1989; Schaeffer, 1993; Barsiene, 1994). Another highly researched pollutant is Tributyltin (TBT), which has toxic effects in a wide variety of biota, whereas inorganic tin is less toxic. TBT effects include lethal toxicity and effects on growth, reproduction, physiology, and behaviour. Several of the negative effects are due to interferences with the endocrine function, as occurs in the phenomenon imposex. Imposex is the superimposition of male organs onto females of gastropods, which are normally a dioecious species (Borja *et al.,* 2012).

9.8.81 Sub-lethal effects of chemical contamination on marine invertebrates can reduce the fitness of individual species. Lethal effects may allow a shift in community composition to one dominated by pollution-tolerant species such as oligochaete worms (Elliott *et al.,* 1998). A reduction in community species richness is associated with elevated levels of pollutants. Contamination with PAHs, for example, leads to high levels of mortality in amphipod and shrimp species, and decreased benthic diversity (Long *et al.,* 1995). Similar reductions in diversity are linked with heavy metal contamination (Dauvin, 2008). Polychaete worms are thought to be quite tolerant of heavy metal contamination, whereas crustaceans and bivalves are considered to be intolerant (Rayment, 2002).

Project impact assessment: Capital dredge

Elevated suspended sediment concentrations

9.8.82 The changes in SSC that are predicted to occur as a result of the capital dredge are considered in more detail in the Physical Processes assessment (Chapter 7 of this ES). In summary, the increased concentrations arising from the capital dredge will be of a lower magnitude and persist for a shorter distance (and time) than that from disposal activity which is summarised below.

9.8.83 Naturally very high SSC typically occur year-round in the Humber Estuary, particularly during the winter months when storm events disturb the seabed and on spring tides (Uncles *et al.,* 2006; Cefas, 2016). The estuarine benthic communities recorded on mudflats and the shallow mud in the region are considered tolerant to this highly turbid environment (De-Bastos and Hiscock, 2016; Tillin, 2016; Ashley, 2016). The predicted SSCs are within the range that can frequently occur naturally and also as a result of ongoing dredge and disposal activity (Chapter 7 of this ES).

9.8.84 In summary, the predicted increases in SSC due to the capital dredging will be localised and temporary based on the Physical Processes assessment (Chapter 7 of this ES). Magnitude of change is assessed as negligible.

Probability of occurrence is high and thus the overall exposure to change is negligible. Based on the evidence provided above, sensitivity of benthic habitats and species within the vicinity of the proposed development to increases in suspended sediments are considered to be low given that these receptors are well adapted to living in high suspended sediment conditions. Vulnerability is therefore assessed as none. While both the subtidal and intertidal benthic communities are considered commonly occurring in the region, subtidal habitats form a component of the 'Estuaries' feature of the SAC. Intertidal habitats are protected (both a qualifying feature of the Humber Estuary SAC and a NERC Habitat of Principle Importance) and of functional importance for waterbirds. Importance is, therefore, considered to range from moderate (for subtidal habitats) to high (for intertidal habitats). The overall effect of suspended sediments on benthic habitats and species is assessed as **insignificant**.

Dissolved oxygen

9.8.85 With respect to dissolved oxygen, increases in SSC will be brief and localised and there is not expected to be a significant reduction in dissolved oxygen as assessed in the Water and Sediment Quality assessment in Chapter 8 of this ES. The probability of a localised effect is, therefore, medium to high but the magnitude of change is considered to be negligible, leading to a negligible exposure to change. On this basis the impact is assessed as **insignificant.**

Release of contaminants

9.8.86 The potential to impact the marine environment as a result of any sediment-bound contaminants arises primarily when the sediment that is released into the water column disperses and deposits elsewhere. However, it should be noted that the majority of material disturbed during capital dredging works will be lifted from the bed to the hopper/barge, with only a small proportion raised into suspension and remaining in the water column (i.e., through abrasion pressure from the draghead/bucket).

9.8.87 Sampling and subsequent chemical analysis has been undertaken in accordance with the agreed MMO sample plan. The results of this analysis are summarised in more detail in the Water and Sediment Quality chapter (Chapter 8 of this ES) and show the majority of contaminants in the sediments of the proposed dredge area are at relatively low concentrations, mostly below, or marginally exceeding, Cefas Action Level 1 (AL1). There were no exceedances of Action level 2 (AL2) in any sediment samples analysed.

9.8.88 Based on the chemical analysis, there are low levels of contamination in sediments in the proposed dredge area. Only a small proportion of disturbed material is expected to be raised into suspension and this material will be rapidly dispersed by strong tidal currents in the area. Significant elevations in the water column contamination are, therefore, not anticipated. Based on these factors, the magnitude of change to subtidal habitat and species will be negligible. Subsequently, exposure of benthic habitats and species to potential contaminants is also assessed as negligible. The sensitivity of

subtidal habitats and species to contaminants is assessed as low to moderate because, although contaminants can cause toxicity in intertidal and subtidal communities, the concentrations of contaminants required to produce both lethal and sub-lethal effects are generally high (although responses vary considerably between species). Thus, marine habitats and species are not considered to be vulnerable to water quality changes associated with the scale of the proposed dredge. Vulnerability is, therefore, assessed as none. While both the subtidal and intertidal benthic communities are considered commonly occurring in the region, subtidal habitats form a component of the 'Estuaries' feature of the SAC. Intertidal habitats are protected (both a qualifying feature of the Humber Estuary SAC and a NERC Habitat of Principle Importance) and of functional importance for waterbirds. Importance is, therefore, considered to range from moderate (for subtidal habitats) to high (for intertidal habitats). Overall, the potential impact to benthic habitats and species arising as a result of disturbance of contaminated sediments is assessed as **insignificant**.

Project impact assessment: Disposal

Elevated suspended sediment concentrations

9.8.89 The hydrodynamic and sediment regime changes that are predicted to occur as a result of the dredge disposal is considered in more detail in the Physical Processes assessment (Chapter 7 of this ES). In summary, the dredge disposal is predicted to produce peak SSC of around 600 to 800 mg/l above background at the disposal site, reducing to typically 100 to 200 mg/l within a distance of around 7 km from the source. These peak increases are predicted to persist at any given location for a single modelled timestep (10 minutes) before the tidal forcing carries the plume further up or down estuary on the respective flood or ebb tide. SSCs of this magnitude are considered to regularly occur naturally or as a result of ongoing maintenance dredging/disposal. Upstream of Hull and downstream (within the outer estuary), maximum SSC levels are lower; generally, between 20 and 100 mg/l above background, as the tidal excursion from the disposal site limits the extent of the resultant plume. However, in reality due to the existing high SSC that typically occurs in the Humber Estuary, the predicted increase in concentrations resulting from the disposal is likely to become immeasurable (against background) within approximately 1 km of the disposal site. The measurable plume from each disposal operation is also only likely to persist for a single tidal cycle (less than 6 hours from disposal) as after this time the dispersion under the peak flood or ebb tidal flows means concentrations will have reverted to background levels.

9.8.90 Naturally very high SSCs typically occur year-round in the Humber Estuary, particularly during the winter months when storm events disturb the seabed and on spring tides. The estuarine benthic communities recorded in the region are considered tolerant to this highly turbid environment (De-Bastos and Hiscock, 2016; Tillin, 2016; Ashley, 2016). The predicted SSCs are within the range that can frequently occur naturally and also as a result of ongoing dredge and disposal activity (Chapter 7 of this ES).

9.8.91 The disposal of sediment will temporarily increase SSC, however, due to the strong hydrodynamic conditions in the area, these temporary elevations in SSC are expected to dissipate rapidly to background concentrations. The magnitude of change is therefore assessed as negligible. Probability of occurrence is high and thus the overall exposure to change is negligible. Sensitivity of benthic features within the disposal ground and surrounding area to increases in suspended sediments are considered to be low given that these species are well adapted to survival in conditions with elevated SSCs. Vulnerability is, therefore, assessed as none. The benthic habitats and associated species that overlap with the changes brought about during disposal are of low ecological value but considered characteristic of the 'Sandbanks which are slightly covered by sea water all the time' feature of the Humber Estuary SAC. Therefore, importance is assessed as moderate. The overall impact is, therefore, assessed as **insignificant**.

Dissolved oxygen

9.8.92 With respect to dissolved oxygen, increases in SSC will be brief and localised and there is not expected to be a significant reduction in dissolved oxygen as assessed in the Water and Sediment Quality assessment in Chapter 8 of this ES. The probability of a localised effect is, therefore, medium to high but the magnitude of change is considered to be negligible, leading to a negligible exposure to change. On this basis the impact is assessed as **insignificant.**

Release of contaminants

9.8.93 The results of the sediment contamination sampling are summarised above and the Water and Sediment Quality chapter (Chapter 8 of this ES). In summary, low levels of contamination were found in the samples and there is no reason to believe the sediment will be unsuitable for disposal in the marine environment.

9.8.94 During disposal, sediment will be rapidly dispersed in the water column. Therefore, the already low levels of contaminants in the dredged sediments will be dispersed further. The probability of changes in water quality occurring at the disposal site is considered to be low and the overall exposure to change is considered to be negligible. The sensitivity of subtidal habitats and species to contaminants is assessed as low to moderate because, although contaminants can cause toxicity in subtidal communities, the concentrations of contaminants required to produce both lethal and sub-lethal effects are generally high (although responses vary considerably between species). Thus, subtidal habitats and species are not considered to be vulnerable to water quality changes at the disposal site in the context of the disposal of the dredged arisings. Vulnerability is, therefore, assessed as none. Benthic habitats and species that overlap with the dispersal plume are of low ecological value but considered characteristic of the 'Sandbanks which are slightly covered by sea water all the time' feature of the Humber Estuary SAC. As a consequence, importance is assessed as moderate. The overall impact is, therefore, assessed as **insignificant**.

Underwater noise and vibration during piling, capital dredging and dredge disposal

General scientific context

9.8.95 Marine invertebrates lack a gas-filled bladder and are thus unable to detect the pressure changes associated with sound waves (Carrol *et al*., 2017). However, all cephalopods as well as some bivalves, echinoderms, and crustaceans have a sac-like structure called a statocyst which includes a mineralised mass (statolith) and associated sensory hairs. Statocysts develop during the larval stage and may allow an organism to detect the particle motion associated with soundwaves in water to orient itself. In addition to statocysts, cephalopods have epidermal hair cells which help them to detect particle motion in their immediate vicinity, comparable to lateral lines in fish. Similarly, decapods have sensory setae on their body, including on their antennae which may be used to detect low-frequency vibrations. Whole body vibrations due to particle motion have been detected in cuttlefish and scallops, although species names and details of associated behavioural responses are not specified.

9.8.96 Scientific understanding of the potential effects of underwater noise on marine invertebrates is relatively underdeveloped (Hawkins *et al.,* 2015). There is limited research to suggest that exposure to near-field low-frequency sound may cause anatomical damage (Carrol *et al*., 2017). Anecdotal evidence indicates there was pronounced statocyst and organ damage in seven stranded giant squid after nearby seismic surveys Guerra *et al*. Airgun exposure can cause damaged statocysts in rock lobsters up to a year later (Day *et al*., 2016). However, no such effects were detected in other studies (Christian *et al.,* 2003). The disparate results between studies seem to be due to differences in sound exposure levels and duration, in some cases due to tank interference, although taxa-specific differences in physical vulnerability to acoustic stress cannot be discounted (Carrol *et al*., 2017).

9.8.97 There is also increasing evidence to suggest that benthic invertebrates behaviourally respond to particle motion (vibration) (Roberts *et al.,* 2016). For example, blue mussels *Mytilus edulis* vary valve gape, oxygen demand and clearance rates (Spiga *et al*., 2016) and hermit crabs *Paganus bernhardus* shift their shell and at very high amplitudes, leave their shell, examine it and then return (Roberts *et al.,* 2016). The vibration levels at which these responses were observed generally correspond to levels measured near anthropogenic operations such as pile driving and up to 300 m from explosives testing (blasting). A range of behavioural effects have also been recorded in decapod crustaceans, including a change in locomotion activity, reduction in antipredator behaviour and change in foraging habits (Tidau and Briffa, 2016). However, population level and mortality effects are considered unlikely.

9.8.98 Based on the evidence provided in the above scientific context review of the potential effects of underwater noise it is considered that effects on population level and mortality in benthic invertebrates are unlikely.

Project impact assessment: Piling

9.8.99 . The proposed development will involve the installation of approximately 214 steel tubular piles, which are estimated to be a maximum of 1,422 mm diameter in size. The piling works will be temporary and short term (anticipated to be completed within a 24-week period, or a 37-week period if a sequenced construction is employed).

9.8.100 Applying the project impact assessment methodology, the probability of a change in underwater noise and vibration occurring during piling is considered to be high. However, the piling activities will be temporary and short term, lasting a period of 24 or 37 weeks, with the vibro and percussive piling noise only taking place for up to a maximum of 20 minutes and 180 minutes per day respectively over that period. Based on these factors, magnitude of the change in underwater noise and vibration due to piling is considered to be negligible. Population level and mortality effects in benthic invertebrates are considered unlikely but the piling may result in short term behavioural responses in some individuals. The sensitivity of the benthic invertebrate species to piling is, therefore, considered to be low. While both the subtidal and intertidal benthic communities are considered commonly occurring in the region, subtidal habitats form a component of the 'Estuaries' feature of the SAC. Intertidal habitats are protected (both a qualifying feature of the Humber Estuary SAC and a NERC Habitat of Principle Importance) and of functional importance for waterbirds. Importance is, therefore, considered to range from moderate (for subtidal habitats) to high (for intertidal habitats). On this basis, the impact of piling noise and vibration on benthic invertebrates is assessed as **insignificant.**

Project impact assessment: Capital dredge and disposal

9.8.101 Based on the above review of the potential effects of underwater noise, population level and mortality effects in benthic invertebrates are not considered likely. Furthermore, dredging is known to produce lower noise levels than piling or blasting, and, therefore, there is unlikely to be significant effects on benthic invertebrates.

9.8.102 Based on the evidence provided above in the scientific review and applying the project impact assessment methodology, the probability of a change in underwater noise and vibration occurring during dredging and disposal is considered to be high. However, dredging and the movement of vessels associated with disposal activities are known to produce lower noise levels than piling. Furthermore, the proposed capital dredge and disposal activities will be short term and temporary, lasting a period of around 80 days (11 weeks) in total. Population level and mortality effects in benthic invertebrates is, therefore, considered unlikely and the only effect that could be expected in the vicinity of the dredging would be short term behavioural responses. Based on these factors, the magnitude of the change in underwater noise and vibration due to dredging and disposal is considered to be negligible. The sensitivity of the benthic invertebrate species to dredging and disposal noise is considered to be low. As noted earlier, however, their overall importance is considered to range from moderate to

high. On this basis, the impact of dredging and disposal noise and vibration on benthic invertebrates is assessed as **insignificant**.

The potential introduction and spread of non-native species

General scientific context

9.8.103 Non-native, or invasive, species are described as 'organisms introduced into places outside of their natural range of distribution, where they become established and disperse, generating a negative impact on the local ecosystem and species' (International Union for Conservation of Nature (IUCN, 2011). The ecological impacts of such 'biological invasions' are considered to be the second largest threat to biodiversity worldwide, after habitat loss and destruction. In the last few decades marine and freshwater systems have been impacted by invasive species, largely as a result of increased global shipping (Carlton and Geller, 1993).

9.8.104 The introduction and spread of non-native species can occur either accidentally or by intentional movement of species as a consequence of human activity (Ruiz and Carlton, 2003 cited in Pearce *et al.,* 2012). The main pathway for the potential introduction of non-native species is via fouling of vessels' hulls, transport of species in ballast or bilge water and the accidental imports from materials brought into the system during development activities. Pathways involving vessel movements (fouling of hulls and ballast water) have been identified as the highest potential risk routes for the introduction of non-native species (Carlton, 1992; Pearce *et al.,* 2012), particularly from different biogeographical regions, which agrees with the fact that areas with a high volume of shipping traffic are hotspots for non-native species in British waters (Pearce *et al.,* 2012).

9.8.105 The fouling of a vessel hull and other below-water surfaces can be reduced through the use of protective coatings. These coatings usually contain a toxic chemical (such as copper) or an irritant (such as pepper) that discourages organisms from attaching. Other coatings, such as those that are silicone-based, provide a surface that is more difficult to adhere to firmly, making cleaning of the hull less laborious. The type and concentration of coatings that can be applied to a boat hull is regulated and can vary between countries. Maintenance of hulls through regular cleaning will minimise the number of fouling organisms present. Hull cleaning can take place on land or in-water. In both cases, care needs to be taken to prevent the organisms and coating particles from being released into the water. By following best management practices, the impact of the cleaning procedure on the environment can be minimised.

9.8.106 Non-native invasive species also have the potential to be transported via ship ballast water. Seawater may be drawn into tanks when the ship is not carrying cargo, for stability, and expelled when it is no longer required. This provides a vector whereby organisms may be transported long distances. In 2004, the International Maritime Organisation (IMO) adopted the 'International Convention for the Control and Management of Ships' Ballast Water and Sediments', which introduced two performance standards seeking to limit the risk of non-native invasive species being imported

(including distances for ballast water exchange and standards for ballast water treatment). The Convention came into force internationally in September 2017.

9.8.107 The UK is bound by international agreements such as the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention 1979), the Convention on the Conservation of European Wildlife and Natural Habitat (Berne Convention, 1979) and the Habitats and Birds Directives. All of these include provisions requiring measures to prevent the introduction of, or control of, non-native species, especially those that threaten native or protected species (JNCC, 2004). Additionally, Section 14(1) of the WCA makes it illegal to release, or allow to escape into the wild, any animal which is not ordinarily resident in Great Britain and is not a regular visitor to Great Britain in a wild state or is listed in Schedule 9 to the WCA.

Project impact assessment

9.8.108 As discussed above, non-native species have the potential to be transported into the study area on ships' hulls during capital dredging and construction activity (such as crane barges used in piling). Non-native invasive species also have the potential to be transported via ship ballast water. Seawater may be drawn into the dredger tanks or hopper when the ship is not carrying cargo, for stability, and expelled when it is no longer required. This provides a vector whereby organisms may be transported long distances.

9.8.109 Within England and Wales, best practice guidance has been developed on how to manage marine biosecurity risks at sites and when undertaking activities through the preparation and implementation of biosecurity plans (Cook *et al.,* 2014). This guidance will be followed when developing biosecurity control measures to minimise the risk of the introduction and spread of non-native species during construction of the scheme. These measures will be included within the CEMP (Application Document reference number 9.2). On this basis, the probability of the introduction and spread of non-native species from the construction phase is considered to be low. However, given that the magnitude of change is unknown, magnitude ranges from negligible to large depending upon the scale and nature of any non-native species introduction, thus the exposure ranges from negligible to low at worst. The sensitivity of all intertidal and subtidal receptors to non-native species introductions is expected to range from low to moderate. Vulnerability is, therefore, considered to be low. In addition, importance is considered to range from high (for intertidal mudflats) to moderate (for subtidal habitats). The overall impact is, therefore, considered to be **insignificant to minor adverse.**

Fish

9.8.110 This section contains an assessment of the potential impacts to fish receptors as a result of the construction phase of the IERRT project. An assessment of the following impact pathways has been undertaken:

- Direct loss or changes to fish populations and habitat as a direct result of dredging and dredge disposal (paragraphs 9.8.111 to 9.8.124);
- Changes in water and sediment quality as a result of dredging and dredge disposal (paragraphs 9.8.125 to 9.8.145); and
- Underwater noise and vibration during piling, capital dredging and dredge disposal (paragraphs 9.8.146 to 9.8.173).

Direct loss or changes to fish populations and habitat as a direct result of dredging and dredge disposal

General scientific context

Indirect effects (food chain)

9.8.111 Seabed sediment removal during dredging has the potential to directly impact demersal fish but, more importantly, could also impact upon the benthic communities that are prey for fish and shellfish, and consequently could alter the distribution and presence of fish species in the region. Fish can have different feeding strategies, for example, some demersal feeders such as cod can show a strong preference for crustacea (Pearce, 2008), whereas species such as plaice, dover sole, lemon sole and dab are benthic invertebrate feeders with a strong preference for polychaetes. Other species such as sand eel and whiting are invertebrate and piscivorous feeders. However, a change in dietary composition as a result of dredging is not considered to be damaging to the fish population as the majority of species are likely to switch to alternate prey sources in the event of an impact on their preferred prey, providing sufficient biomass is available to support them (Pearce, 2008).

Indirect effects (habitat change)

9.8.112 Should the removal of seabed sediments during dredging lead to habitat loss, it could potentially impact on key habitats including spawning, nursery and overwintering grounds that have an important ecological function. Fish species that spawn directly onto the seabed are more sensitive to the effects of seabed removal due to dredging than those that spawn into the water column. For example, herring use coarse sediments as spawning grounds. Herring along with sand eel species which live within the sediment are considered particularly sensitive to habitat change (Tillin *et al.,* 2011).

Direct effects (uptake)

9.8.113 Hydraulic entrainment, through the direct uptake of aquatic organisms by the suction field generated at the draghead or cutterhead during dredging operations has the potential to result in the by-catch of fish eggs, larvae and even mobile juveniles and adults (Wenger *et al.*, 2017).

9.8.114 Limited research has been carried out regarding entrainment rates of fish in marine dredging. Lees *et al*. (1992) sampled the outwash from an aggregate dredger in the English Channel and recorded the species. In five x 10 minute samples, 22 fish were sampled and a further red gurnard was found from the surface of the hopper cargo. Most fish appeared physically undamaged and would have been washed back to sea, however the scope of the study did not include assessments of their subsequent survival rates. Demersal fish with poorer hearing sensitivity including flatfish and

elasmobranchs are considered more likely to be entrained by the dredger drag head (Reine and Clarke, 1998; Stelzenmuller *et al*. 2010). Large and active demersal and pelagic juvenile and adult finfish are likely to avoid dredging areas during operations in response to noise levels and increased turbidity (Tillin *et al.,* 2011).

9.8.115 In general, eggs, embryo and larval stages are considered more vulnerable to entrainment than adults. While the entrainment rates are likely to represent a small proportion of total larval production, fish entrained at the egg, embryo and larval stages will experience extremely high mortality rates although mortality rates will vary among fish species and development stages (Wenger *et al*., 2017).

Project impact assessment: Capital dredge

9.8.116 Habitat change could potentially impact on critical habitats including spawning, nursery and feeding grounds that have an important ecological function for fish.

9.8.117 However, the dredge footprint is considered unlikely to provide important nursery or spawning functions for fish species as a result of the existing disturbed nature of this habitat despite known nursery or spawning areas for species such as Dover sole, whiting or cod occurring in the wider Humber Estuary area.

9.8.118 Potential prey items for flatfish and demersal fish such as the mud shrimp *Corophium volutator* and polychaete worms were recorded during the project specific intertidal and subtidal surveys (Appendix 9.1 to this ES) (Ashley and Budd, 2020). However, most fish species are opportunistic and generalist feeders, which means that they are generally not reliant on a single prey item. Fish are also mobile species and will easily be able to move away from the zone of influence and utilise other nearby areas for foraging. Furthermore, the area of habitat loss and change will only represent a small proportion of the foraging ranges of many fish species (particularly the larger and more commercial species such as whiting, plaice and Dover sole).

9.8.119 During dredging, there is the potential for fish along with roe (eggs) of these species to be removed. The region is known to support Dover sole spawning grounds. Dover sole spawn on a range of substrates in inshore waters. However, the dredge footprint and nearby area is already subject to regular natural seabed disturbance due to strong tidal currents and also seabed disturbance as a result of existing vessel movements and ongoing maintenance dredging. As a result, the proposed dredge footprint and nearby area is likely to provide disturbed and sub-optimal spawning conditions with more optimal habitat present in the wider region. In addition, the dredge footprint is considered negligible in the context of suitable nursery habitat in the region.

9.8.120 Based on these factors, magnitude is considered to be small and probability medium. Consequently, the exposure of all fish to direct habitat changes is

considered to be negligible to low. The sensitivity of fish to habitat change on the scale predicted is considered to be low, leading to a low vulnerability. Therefore, while the overall importance of certain fish species is high (i.e. for fish species of conservation interest), the impact is assessed as **insignificant to minor**.

Project impact assessment: Disposal

9.8.121 The disposal of dredged material at the marine disposal sites will result in the deposition of sediments which has the potential to cause physical disturbance and smothering of seabed habitats.

9.8.122 The disposal grounds are located in a highly dynamic area with the mobile sandbanks subject to regular natural physical disturbance (and associated scouring) as a result of very strong tidal flows and deposition due to regular maintenance dredge activity. This is reflected in a highly impoverished benthic assemblage at both disposal sites (characterised by a few opportunistic species in very low numbers). This area is, therefore, likely to provide limited prey resources for fish species. In addition, as described above, benthic infaunal species characterising the disposal site are considered likely to show some tolerance to sediment deposition and also rapid recoverability rates. On this basis, potential effects on prey resources for fish are expected to be of low magnitude and temporary. Fish are also mobile species and will easily be able to move away from the zone of influence and return following the cessation of disposal activity.

9.8.123 The highly disturbed nature of the seabed is also unlikely to provide suitable conditions as a spawning or nursery area for fish.

9.8.124 Based on these factors, magnitude is considered to be small and probability medium. Consequently, the exposure of all fish to direct habitat changes is considered to be negligible to low. The sensitivity of fish to habitat change on the scale predicted is considered to be low, leading to a low vulnerability. Therefore, while the overall importance of certain fish species is high (i.e. for fish species of conservation interest), the impact is assessed as **insignificant to minor**.

Changes in water and sediment quality as a result of dredging and dredge disposal

General scientific context

Elevated suspended sediment concentrations

9.8.125 Increased suspended sediments can lead to physiological effects in adult finfish resulting from the abrasion of sediment particles on gill tissues, causing reduced gill function and possible mortality (Wenger *et al.*, 2017; Kjelland *et al.,* 2015). Such effects on fish are considered to occur at suspended sediment levels of around 10,000 mg/l (Britwell, 2000). High SSC levels may impact spawning and nursery grounds through damage to eggs and planktonic larvae, as well as causing abrasion or clogging of the fragile gills of larval and juvenile fish, resulting in mortality or reduced growth rates.

9.8.126 Because turbidity often impairs visual acuity, activities and processes that require vision can be inhibited, leading to behavioural responses. For example, foraging in both planktivorous and piscivorous fish can be negatively affected by suspended sediments. Piscivores are especially sensitive to increasing turbidity because many are visual hunters that detect prey from a distance. An increase in suspended sediment reduces both light and contrast, decreasing encounter distances between predator and prey (Wenger *et al*., 2017).

9.8.127 Elevated suspended sediments can also influence the movements and migration of fish. For example, a range of salmonid species have been observed actively avoiding moving through areas with suspended sediment plumes (Wenger *et al*., 2017; Kjelland *et al.,* 2015). However, such responses can cease if fish become acclimatised. Fish in high latitude coastal areas typically have to contend with variable turbidity and often poor visual conditions, resulting from fluctuations in ambient light levels, suspended sediments and in the light transmission properties of the water. For example, concentrations as high as 9,000 mg/l have been recorded in the path of salmon runs in the Usk Estuary (Alabaster, 1993). Similarly, lamprey and shad species have been known to successfully pass through estuaries with extremely high suspended sediments and, therefore, can be considered tolerant of turbid conditions (Scottish Government, 2010). The mobile nature of fish species generally allows avoidance of areas of adverse conditions which are unlikely to significantly affect a population provided such conditions are temporary.

Organic enrichment and oxygen depletion

9.8.128 The resuspension of sediments containing organic material can cause oxygen depletion within the water column. The subsequent settling of this organic rich sediment can deplete the sediments of oxygen and affect benthic prey items used by fish. The response of fish to low concentrations of dissolved oxygen is determined by a range of factors, including the duration of exposure, water temperature and the presence of other pollutants (Wenger *et al*., 2017). The duration of any low dissolved oxygen event is a key factor in determining its effect. Most fish would survive an extremely low concentration of dissolved oxygen, such as 2 mg/l, for a few minutes, but a longer exposure would start to have sub-lethal and eventually lethal effects (ABP Research, 2000).

Release of contaminants

9.8.129 The potential release of contaminants during construction and dredging activities may result in those contaminants becoming available for uptake by any fish in the water column or on surface sediments. There is an indirect risk to some finfish species as sediment-bound contaminants may temporarily bioaccumulate in the tissues of certain fish prey, such as polychaete worms and marine bivalves, and made available for uptake by feeding fish.

9.8.130 The influence of contaminated sediments is considered to have a greater impact on fish than elevated SSC with a range of evidence suggesting that

direct exposure to contaminants negatively effects fish (Wenger *et al*., 2017). Hydrophobic contaminants (such as legacy persistent organic pollutants including PCBs and organochlorine pesticides) as well as high-molecular weight polyaromatic and aliphatic hydrocarbons (such as PAHs), are closely associated with organic material in sediments. These contaminants have been linked to a range of potential reproductive impacts on adult fish (e.g. steroidogenesis, vitellogenesis, gamete production or spawning success) as well as lethal and non-lethal developmental (spinal and organ development, growth) impacts on embryos and larvae (Johnson *et al.,* 2014).

9.8.131 Demersal fish species, such as dab and flounder, which remain close to the seabed and feed mainly on benthic organisms, would experience a higher exposure to contaminated sediments than pelagic fish such as herring.

Project impact assessment: Capital dredge

9.8.132 The changes in SSC that are predicted to occur as a result of the capital dredge are considered in more detail in the Physical Processes assessment (Chapter 7 of this ES) and summarised above in the 'Benthic habitats and species' sub-section (paragraphs 9.8.82 to 9.8.84).

9.8.133 As noted in the preceding section, fish within the Humber Estuary are well adapted to living in an area with variable and typically very high year-round suspended sediment loads. Fish feed on a range of food items and, therefore, their sensitivity to a temporary change in the availability of a particular food resource is considered to be low. Their high mobility enables them to move freely to avoid areas of adverse conditions and to use other food sources in the local area.

9.8.134 As highlighted above, salmonids and other migratory fish can be sensitive to elevated SSC However, Atlantic salmon and sea trout are both known to migrate through estuaries with high SSC to get to spawning areas (including the Humber Estuary which is considered one of the estuaries in the UK with the highest levels of SSCs) (Salmon and Trout Conservation, 2017; Wenger *et al*., 2017; Kjelland *et al*., 2015; Uncles *et al.,* 2006; Cefas, 2016). Other migratory species such as lamprey and shad species also pass through estuaries with high suspended sediments. Elevated SSCs due to dredging are considered to be of a magnitude that can, as noted, occur naturally or as a result of ongoing maintenance dredging/disposal.

9.8.135 Sediment plumes resulting from dredging will be relatively localised (in the context of the entire width of the estuary). It is considered that they will dissipate relatively rapidly and be immeasurable against background levels within a relatively short duration of time (less than a single tidal cycle) as described in more detail in the Physical Processes assessment (Chapter 7 of this ES). Therefore, salmonids and other migratory fish will also be able to avoid the temporary sediment plumes. Based on these factors there is considered to be limited potential for migrating fish to be adversely affected by the predicted changes in SSC.

9.8.136 Given that elevated SSCs due to dredge and dredge disposal are considered to be in the range of variability that can occur naturally in the Humber Estuary (which has very high SSCs year-round, particularly during the winter months) as well as due to ongoing maintenance dredging/disposal and that plumes will be temporary in nature, sensitive life stages of fish occurring in the region such as larvae and juvenile fish are considered unlikely to be adversely affected by the dredging.

9.8.137 Whilst, therefore, the probability of a localised and temporary change is high, the magnitude of change will be negligible and consequently exposure to change is assessed as negligible. Sensitivity of fish is assessed as low to moderate and consequently vulnerability is assessed as none. It follows that although the overall importance of certain fish species is high (i.e. for fish species of conservation interest), the impact is assessed as **insignificant**.

9.8.138 With respect to dissolved oxygen, increases in SSC will be brief and localised and there is not expected to be a significant reduction in dissolved oxygen as assessed in the Water and Sediment Quality assessment in Chapter 8 of this ES. The probability of a localised effect is, therefore, medium to high but the magnitude of change is considered to be negligible, leading to a negligible exposure to change. Whilst the sensitivity of fish is considered to be low to moderate and certain species have a high nature conservation importance, the impact is assessed as **insignificant.**

9.8.139 With respect to sediment contamination, generally low levels of contamination were found in the sediment contamination samples as presented in the Water and Sediment Quality assessment in Chapter 8 of this ES.

9.8.140 Based on this sampling data, the overall level of contamination in the proposed dredge area is considered to be low and the sediment plume would be expected to rapidly dissipate by the strong tidal currents in the area. Significant elevations in the concentrations of contaminants within the water column are not anticipated. Based on these factors, therefore, the magnitude of change to fish species is considered to be negligible. Subsequently, exposure of fish species to potential contaminants is assessed as negligible. Given that the sensitivity of fish is considered to be low to moderate and the overall importance is considered to range from low to high, depending on the ecological value and protected status of individual species, the impact is assessed as **insignificant.**

Project impact assessment: Dredge disposal

9.8.141 The changes in SSC that are predicted to occur as a result of the disposal activities are considered in more detail in the Physical Processes assessment (Chapter 7 of this ES) and summarised above in the ‘Benthic Habitats and Species’ impact assessment sub-section (paragraphs 9.8.89 to 9.8.91).

9.8.142 The disposal of sediment will temporarily increase SSC, however, due to the strong hydrodynamic conditions in the area, these temporary elevations in SSC are expected to rapidly dissipate to background concentrations within a matter of hours and before the next disposal. As highlighted above, migratory species including Atlantic salmon are known to migrate through estuaries with high SSC (including the Humber Estuary which is considered one of the estuaries in the UK with the highest levels of SSC) (Uncles *et al*., 2006) and the predicted SSC are within the range that can frequently occur naturally and also as a result of ongoing dredge and disposal activity. Sediment plumes resulting from disposal will also be relatively localised in the context of the entire width of the estuary. Therefore, salmonids and other migratory fish would also be able to avoid the temporary sediment plumes.

9.8.143 Based on these factors, the magnitude of change is assessed as negligible. Probability of occurrence is high and thus the overall exposure to change is negligible. Therefore, while the sensitivity of fish is low to moderate and certain species have a high nature conservation importance (e.g. migratory Atlantic salmon and lamprey) any impact is assessed as **insignificant**.

9.8.144 With respect to sediment contamination, the results of the sediment contamination sampling are summarised above, and in the Water and Sediment Quality chapter (Chapter 8 of this ES). In summary, generally low levels of contamination were found in the samples and there is no reason to believe the sediment will be unsuitable for disposal in the marine environment.

9.8.145 Based on the results of the sediment sampling survey, the overall level of contamination in the proposed dredge area is considered to be low. During disposal, sediment will be rapidly dispersed in the water column. As a consequence, the already low levels of contaminants in the dredged sediments will be dispersed further. The probability of changes in water quality occurring at the disposal site is considered to be low and the overall exposure to change is considered to be negligible. Whilst, therefore, the sensitivity of fish is low to moderate and certain species have a high nature conservation importance, any impact will be **insignificant**.

Underwater noise and vibration during piling, capital dredging and dredge disposal

General scientific context

9.8.146 Elevated underwater noise and vibration levels during construction activities can potentially disturb fish by causing physiological damage and/or inducing adverse behavioural reactions. A detailed underwater noise assessment has been undertaken for the proposed development (Appendix 9.2 of the ES) and is briefly summarised in this section.

9.8.147 For most piling activities, the main source of noise and vibration relates to where piles are hammered or vibrated into the ground. Percussive piling involves hammering the pile into the seabed resulting in an impact blow and high levels of noise. Vibro-piling produces lower levels of noise as piles are vibrated into the seabed.

9.8.148 The dredging process involves a variety of sound generating activities which can be broadly divided into sediment excavation, transport and placement of the dredged material at the disposal site (CEDA, 2011; WODA, 2013; Jones and Marten, 2016). For most dredging activities, the main source of sound relates to the vessel engine noise.

9.8.149 There is a wide diversity in hearing structures in fish which leads to different auditory capabilities across species (Webb *et al*., 2008). All fish can sense the particle motion[24] component of an acoustic field via the inner ear as a result of whole-body accelerations (Radford *et al*., 2012), and noise detection ('hearing') becomes more specialised with the addition of further hearing structures. Particle motion is especially important for locating sound sources through directional hearing (Popper *et al*., 2014; Hawkins *et al*., 2015; Nedelec *et al*., 2016). Although many fish are also likely to detect sound pressure[25], particle motion is considered equally or potentially more important (Hawkins and Popper, 2017).

9.8.150 From the few studies of hearing capabilities in fish that have been conducted, it is evident that there are potentially substantial differences in auditory capabilities from one fish species to another (Hawkins and Popper, 2017). Popper *et al.* (2014) proposed the following three categories of fish which are described below:

- Fish with a swim bladder or air cavities that aid hearing;
- Fish with a swim bladder that does not aid hearing; and
- Fish with no swim bladder.

9.8.151 The first category comprises fish that have special structures mechanically linking the swim bladder to the ear. Fish species in the study area that fall within this first category include herring (*Clupea harengus*) and shads.

9.8.152 The second category comprises fish with a swim bladder where the organ does not appear to play a role in hearing. Fish species in the study area that fall within this second category include Atlantic cod (*Gadus morhua*), Atlantic salmon (*Salmo salar*), European eel (*Anguilla anguilla*), European seabass (*Dicentrarchus labrax*), Atlantic mackerel (*Scomber scombrus*), smelt (*Osmerus eperlanus*) and whiting (*Merlangius merlangus*).

9.8.153 The third category comprises fish lacking swim bladders that are sensitive only to sound particle motion and show sensitivity to only a narrow band of frequencies (e.g., flatfishes, sharks, skates and rays). Fish species in the study area that fall within this third category include plaice (*Pleuronectes platessa*), sea lamprey (*Petronmyzon marinus*), sole (*Solea solea*) and thornback ray (*Raja clavata*).

[24] Particle motion is a back and forth motion of the medium in a particular direction; it is a vector quantity that can only be fully described by specifying both the magnitude and direction of the motion, as well as its magnitude, temporal, and frequency characteristics.

[25] Pressure fluctuations in the medium above and below the local hydrostatic pressure; it acts in all directions and is a scalar quantity that can be described in terms of its magnitude and its temporal and frequency characteristics.

Project impact assessment: Piling

9.8.154 The distances at which potential mortality/injury and behavioural effects in fish are predicted to occur as a result of the percussive piling and vibro-piling associated with the development are included in Appendix 9.2 to this ES.

9.8.155 The predicted range (R) at which the Popper *et al.* (2014) quantitative instantaneous peak Sound Pressure Level (SPL) thresholds for pile driving are reached indicates that there is a risk of mortality, potential mortal injury or recoverable injury within 22 m from the source of impact piling in fish with a swim bladder (such as herring, Atlantic salmon and European eel) and within 10 m in fish with no swim bladder (such as lamprey and flatfish). For vibro-piling, there is a risk of mortality, potential mortal injury or recoverable injury within 3 m from the source in fish with a swim bladder and within 1 m in fish with no swim bladder.

9.8.156 The calculator developed by the United States National Marine Fisheries Service (NMFS) (NMFS, 2021) as a tool for assessing the potential effects to fish exposed to elevated levels of underwater sound produced during pile driving was used to calculate the range at which the cumulative Sound Exposure Levels (SEL) thresholds for pile driving (Popper *et al*., 2014) are reached. Based on the assumptions highlighted in Appendix 9.2 to this ES, there is predicted to be a risk of mortality and potential mortal injury within 72 m from the source of impact piling in fish with a swim bladder involved in hearing (such as herring), within 49 m from the source in fish with a swim bladder not involved in hearing (such as European eel) and within 15 m in fish with no swim bladder (such as sole). The distance at which the received level of noise is within the limits of the recoverable injury threshold is within 121 m in fish with a swim bladder and 23 m in fish without a swim bladder. For vibro-piling, there is predicted to be a risk of mortality and potential mortal injury within 38 m from the source in fish with a swim bladder involved in hearing, within 26 m from the source in fish with a swim bladder not involved in hearing and within 8 m in fish with no swim bladder. The distance at which the received level of noise is within the limits of the recoverable injury threshold is within 64 m in fish with a swim bladder and 12 m in fish without a swim bladder.

9.8.157 Given the mobility of fish, any individuals that might be present within the localised areas associated with potential mortality/injury during pile driving activities would be expected to easily move away and avoid harm. Furthermore, the area local to the proposed development is not considered a key foraging, spawning or nursery habitat for fish and, therefore, this localised zone of injury is unlikely to result in any significant effects on fish.

9.8.158 The range at which the Hawkins *et al*. (2014) quantitative instantaneous peak SP['L behaviour thresholds for percussive pile driving are reached indicates that there is a risk of a behavioural response in fish within around 1.6 km from the impact piling. Behavioural reactions during impact piling are, therefore, anticipated to occur across 67% width of the Humber Estuary at low water and 46% of the estuary width at high water, potentially creating

a partial temporary barrier to fish movements. For vibro-piling, there is a risk of a behavioural response in fish within around 1.1 km from the source which equates to 48% of the width of the Humber Estuary at low water and 33% of the estuary width at high water.

9.8.159 The scale of the behavioural response is partly dependent on the hearing sensitivity of the species. The key fish in the study area include species across the range of Popper *et al.* (2014) fish hearing groups. Fish with a swim bladder involved in hearing (e.g., herring) may exhibit a moderate behavioural reaction within a distance in which a behavioural response is predicted (e.g., a sudden change in swimming direction, speed or depth). Fish with a swim bladder that is not involved in hearing (e.g. European eel) are likely to display a milder behavioural reaction. Fish without a swim bladder (e.g. river lamprey) are likely to show only very subtle changes in behaviour in this zone.

9.8.160 The scale of the behavioural effect is also dependent on the size of fish (which affects maximum swimming speed). Smaller fish, juveniles and fish larvae swim at slower speeds and are likely to move passively with the prevailing current. Larger fish are more likely to actively swim and, therefore, may be able to move out of the behavioural effects zone in less time, although it is recognised that the movement of fish is very complex and not possible to define with a high degree of certainty.

9.8.161 The effects of piling noise on fish also need to be considered in terms of the duration of exposure. It is anticipated that piling noise will take place for a very small amount of time each day over a period of approximately 24 or 37 weeks (depending on whether a sequenced construction is employed). Piling will not take place continuously over that period as there will be periods of downtime, pile positioning and set up.

9.8.162 The piling works will be undertaken Monday to Sunday. The maximum impact piling scenario is for 4 tubular piles to be installed each day from either front (i.e. the land and water), involving approximately 180 minutes of impact piling per day and 20 minutes of vibro piling per day. It should be noted, however, that in terms of potential disturbance, four piles a day is very much a worst case scenario. Either way, there will clearly be significant periods over a 24-hour period when fish will not be disturbed by any piling noise. The actual proportion of piling is estimated to be at worst around 14% (based on 180 minutes of impact piling and 20 minutes of vibro piling) each working day over any given construction week. In other words, any fish that remain within the predicted behavioural effects zone at the time of piling will be exposed a maximum of up to 14% of the time on the assumption that four piles are driven in a given day – which is considered to be unlikely.

9.8.163 It is also important to consider the noise from piling against existing background or ambient noise conditions. The wider local area in which the construction will take place already experiences regular vessel operations

and ongoing maintenance dredging, and, therefore, fish are likely to be habituated to a certain level of anthropogenic background noise.

9.8.164 Applying the standard impact assessment criteria, the probability of occurrence of underwater noise disturbance during piling is high. Given the uncertainty regarding the actual timing and programme for the piling, this assessment has been undertaken on the basis that the works could take place at any time of year as a worst case. There is the potential for piling to occur during the sensitive migratory periods of fish in the Humber Estuary, including the migratory periods of diadromous fish such as Atlantic salmon, European smelt, European eel, shads and lamprey. Migratory fish moving between the Humber Estuary and the sea could potentially pass near to the proposed marine works (with a risk of injury potentially occurring in very close proximity to the piling activity). In addition, behavioural response (e.g., displacement) or acoustic barrier could occur over the entire width of the Humber Estuary at low water and the majority of the estuary width at high water. Magnitude and consequently exposure to change is, therefore, considered to be medium for these migratory species.

9.8.165 The sensitivity of Atlantic salmon, sea trout, European smelt, shads and European eel is considered to be moderate with the sensitivity of lamprey species low based on the Popper *et al*. (2014) fish noise exposure criteria. All diadromous fish species are considered to have a high importance due to their conservation value and protection. On this basis, whilst only temporary and short term in duration, the effect on Atlantic salmon, sea trout, European smelt, shads, European eel is considered to be **moderate adverse** and the effect to lamprey species **minor adverse**.

9.8.166 In terms of other fish occurring in the Humber Estuary, the effect is considered to be **insignificant to minor adverse**. This is based on these other fish having a range of sensitivities from low to moderate and a low to medium importance in terms of nature conservation status.

Project impact assessment: Capital dredge and dredge disposal

9.8.167 The relative risk and distances at which potential mortality/injury and behavioural effects in fish are predicted to occur as a result of the dredging and vessel movements associated with the construction and operation of the proposed development are included in Appendix 9.2 to this ES.

9.8.168 The worst case source level (SL) generated by dredging and vessels is below the Popper *et al.* (2014) quantitative instantaneous peak SPL and cumulative SEL thresholds for pile driving, which indicates that there is no risk of mortality, potential mortal injury or recoverable injury in all categories of fish even at the very source of the dredger or vessel noise. This appears to correlate with the Popper *et al*. (2014) recommended qualitative guidelines for continuous noise sources which consider that the risk of mortality and potential mortal injury in all fish is low in the near, intermediate and far-field.

9.8.169 According to Popper *et al.* (2014), the risk of recoverable injury is also considered low for fish with no swim bladder and fish with a swim bladder that is not involved in hearing. There is a greater risk of recoverable injury in fish where the swim bladder is involved in hearing (e.g. herring) whereby a cumulative noise exposure threshold is recommended (170 dB rms for 48 h). The distance at which recoverable injury is predicted in these fish as a result of the dredging and vessel movements is 10 m.

9.8.170 Popper *et al*. (2014) advise that there is a moderate risk of temporary threshold shifts (TTS) occurring in the nearfield (i.e., tens of metres from the source) in fish with no swim bladder and fish with a swim bladder that is not involved in hearing and a low risk in the intermediate and far-field. There is a greater risk of TTS in fish where the swim bladder is involved in hearing (e.g., herring) when a cumulative noise exposure threshold is recommended (158 dB rms for 12 h). The distance at which TTS is predicted in these fish as a result of the dredging and vessel movements is 46 m.

9.8.171 Popper *et al.* (2014) guidelines suggest that there is considered to be a high risk of potential behavioural responses occurring in the nearfield (i.e., tens of metres from the source) for fish species with a swim bladder involved in hearing and a moderate risk in other fish species. At intermediate distances (i.e., hundreds of metres from the source), there is considered to be a moderate risk of potential behavioural responses in all fish and in the farfield (i.e., thousands of metres from the source) there is considered to be a low risk of a response in all fish.

9.8.172 Overall, there is considered to be a low risk of any injury in fish as a result of the underwater noise generated by dredging and vessel movements although recoverable injury could potentially occur in very close proximity to the dredger in fish where the swim bladder is involved in hearing (e.g., herring). The level of exposure will depend on the position of the fish with respect to the source, the propagation conditions, and the individual's behaviour over time. However, it is unlikely that a fish would remain in the vicinity of a dredger for extended periods given the distances at which recoverable injury or TTS are predicted in fish as a result of the dredging and vessel movements, as explained in paragraphs 9.8.169 and 9.8.170. Behavioural responses are anticipated to be spatially negligible in scale and fish will be able to move away and avoid the source of the noise as required. Furthermore, the period of dredging will be short term (approximately 80 days (11 weeks) in total).

9.8.173 Based on the above considerations, the overall magnitude of the change in underwater noise due to dredging and possible disposal activities is considered to be negligible. Probability of occurrence is high and thus the overall exposure to change is negligible. While sensitivities of fish to underwater noise ranges from low to moderate depending on the Popper *et al.* (2014) category within which the fish species falls, vulnerability is assessed as none. The importance of fish ranges from high for fish of high nature conservation status to low for resident fish with no protected status

and which are not of commercial value. Overall, therefore, the impact of underwater noise during dredging and disposal activities on fish is considered to be **insignificant.**

Marine mammals

9.8.174 This section contains an assessment of the potential impacts to marine mammal receptors as a result of the construction phase of the IERRT project. The following impact pathway have been assessed:

- Underwater noise and vibration during piling, capital dredging and dredge disposal (paragraphs 9.8.175 to 9.8.204).

Underwater noise and vibration during piling, capital dredging and dredge disposal

General scientific context

9.8.175 Elevated underwater noise and vibration levels during construction activities has the potential to causing physiological damage and induce adverse behavioural reactions. A detailed Underwater Noise assessment has been undertaken for the proposed development (Appendix 9.2 to this ES) and is briefly summarised in this section.

9.8.176 For most piling activities, the main source of noise and vibration relates to where piles are hammered or vibrated into the ground. Percussive piling involves hammering the pile into the seabed resulting in an impact blow and high levels of noise. Vibro-piling produces lower levels of noise as piles are vibrated into the seabed.

9.8.177 The dredging process involves a variety of sound generating activities which can be broadly divided into sediment excavation, transport and placement of the dredged material at the disposal site (CEDA, 2011; WODA, 2013; Jones and Marten, 2016). For most dredging activities, the main source of sound relates to the vessel engine noise.

9.8.178 Marine mammals are particularly sensitive to underwater noise at higher frequencies and generally have a wider range of hearing than other marine fauna, namely fish (i.e. their hearing ability spans a larger range of frequencies). The hearing sensitivity and frequency range of marine mammals varies between different species and is dependent on their physiology.

9.8.179 The National Oceanic and Atmospheric Administration (NOAA) (2018) provides technical guidance for assessing the effects of underwater anthropogenic (human-made) sound on the hearing of marine mammal species. Specifically, the received levels, or acoustic thresholds, at which individual marine mammals are predicted to experience changes in their hearing sensitivity (either temporary or permanent) for acute, incidental exposure to impulsive and non-impulsive underwater anthropogenic sound sources are provided. These thresholds update and replace the previously proposed criteria in Southall *et al.* (2007) for preventing auditory/physiological injuries in marine mammals. Further

recommendations have recently been published regarding marine mammal noise exposure by Southall *et al.* (2019) which complement the NOAA (2018) thresholds and also look at a wider range of marine mammal species.

9.8.180 The NOAA (2018) and Southall *et al.* (2019) thresholds are categorised according to marine mammal hearing groups. The key marine mammal species found in the study area for the scheme comprise harbour porpoise, common seal and grey seal. According to NOAA (2018), harbour porpoise is categorised as a high-frequency (HF) cetacean and common and grey seals are categorised as phocid pinniped (PW) (earless seals or "true seals").

9.8.181 There are no equivalent SPL behavioural response criteria that would represent the sources of underwater noise associated with the proposed development. Behavioural reactions to acoustic exposure are less predictable and difficult to quantify than effects of noise exposure on hearing or physiology as reactions are highly variable and context specific (Southall *et al*., 2007).

9.8.182 Field studies have demonstrated behavioural responses of harbour porpoises to anthropogenic noise (Cefas, 2020). A number of studies have shown avoidance of pile driving activities during offshore wind farm construction (Brandt *et al.*, 2011; Carstensen *et al.*, 2006; Dähne *et al.,* 2013), with the range of measurable responses extending to at least 21 km in some cases (Tougaard *et al*., 2009). Seismic surveys have also elicited avoidance behaviour in harbour porpoises, albeit short-term (Thompson *et al.,* 2013), and monitoring of echolocation activity suggests possible negative effects on foraging activity in the vicinity of seismic operations (Pirotta *et al.,* 2014). There is a scarcity of studies quantifying behavioural impacts from dredging (Thomsen *et al.,* 2011). An investigation by Diederichs *et al.* (2011) showed that harbour porpoises temporarily avoided an area of sand extraction off the Island of Sylt in Germany. Diederichs *et al.* (2011) found that, when the dredging vessel was closer than 600 m to the porpoise detector location, it took three times longer before a porpoise was again recorded than during times without sand extraction. However, after the ship left the area, the clicks made by harbour porpoise (for echolocation) resumed to the baseline rate.

9.8.183 Few studies have documented responses of seals to underwater noise in the field (Cefas, 2020). Tracking studies found reactions of the grey seals to pile driving during the construction of windfarms were diverse (Aarts *et al*., 2017). These included altered surfacing or diving behaviour, and changes in swim direction including swimming away from the source, heading into shore or travelling perpendicular to the incoming sound, or coming to a halt. Also, in some cases no apparent changes in their diving behaviour or movement were observed. Of the different behavioural changes observed a decline in descent speed occurred most frequently, which suggests a transition from foraging (diving to the bottom) to more horizontal movement. These changes in behaviour were on average larger, and occurred more

frequently, at smaller distances from the pile driving events, and such changes were statistically significantly different at least up to 36 km from the piling. In addition to changes in dive behaviour, also changes in movement were recorded. There was evidence that on average grey seals within 33 km were more likely to swim away from the pile driving. In some cases, seals exposed to pile-driving at close range, returned to the same area on subsequent trips. This suggests that some seals had an incentive to go to these areas, which was stronger than the deterring effect of the pile-driving.

9.8.184 A telemetry study found no overall significant displacement of common seal during construction of a wind farm in The Wash, south-east England (Russell *et al*., 2016). However, during piling, seal usage (abundance) was significantly reduced up to 25 km from the piling activity; within 25 km of the centre of the wind farm, there was a 19 to 83% (95% confidence intervals) decrease in usage compared to during breaks in piling, equating to a mean estimated displacement of 440 individuals. This amounts to significant displacement starting from predicted received levels of between 166 and 178 dB re 1 µPa (peak-peak). Displacement was limited to piling activity; within 2 hours of cessation of pile driving, seals were distributed as per the non-piling scenario.

9.8.185 Koschinski *et al.* (2003) conducted a playback experiment on harbour seals in which the recorded sound of an operational wind turbine was projected via a loudspeaker, resulting in modest displacement of seals from the source (median distance was 284 vs 239 m during control trials). Two further studies of ringed seals (*Phoca hispida*), which are closely related to both harbour and grey seals, have observed behaviour in response to anthropogenic noise: Harris *et al*., (2001) reported animals swimming away and avoidance within ~150 m of a seismic survey, while Moulton *et al*., (2003) found no discernible difference in seal densities in response to construction and drilling for an oil pipeline.

9.8.186 A number of field observations of harbour porpoise and pinnipeds to multiple pulse sounds have been made and are reviewed by Southall *et al*. (2007). The results of these studies are considered too variable and context-specific to allow single disturbance criteria for broad categories of taxa and of sounds to be developed. Another way to evaluate the responses of marine mammals and the likelihood of behavioural responses is by comparing the received sound level against species specific hearing threshold levels. Further information on the dB_{ht} metric and its limitations is provided in Section 7.3 of Appendix 9.2 of the ES.

Project impact assessment: Piling

9.8.187 The distances at which permanent threshold shifts (PTS), TTS and behavioural effects in marine mammals that occur in the study area are predicted to occur during impact piling and vibro-piling for the proposed development are included in Appendix 9.2 to this ES.

9.8.188 There is predicted to be a risk of instantaneous PTS and TTS in harbour porpoise within 42 m and 90 m respectively from the source of the

percussive piling noise. The risk of instantaneous PTS and TTS in seals is within 5 m and 12 m respectively.

9.8.189 If the propagation of underwater noise from impact piling were unconstrained by any boundaries, the maximum theoretical distance at which the predicted cumulative SEL weighted levels of underwater noise during impact piling is within the limits of PTS and TTS in harbour porpoise is 1.8 km and 12.6 km respectively. The maximum distance for PTS and TTS in seals is 0.9 km and 6.5 km respectively. The maximum theoretical distance at which the predicted cumulative SEL weighted levels of underwater noise during vibro piling is within the limits of PTS and TTS in harbour porpoise is 94 m and 1.2 km respectively. The maximum distance for PTS and TTS in seals is 44 m and 581 m respectively.

9.8.190 Assuming a worst case of a lower swimming speed of 1.5 m/s for all marine mammal species (including both adults and juveniles), the maximum time that would take harbour porpoise to leave the centre of the cumulative SEL weighted PTS and TTS injury zones during impact piling is estimated to be 20 minutes and 2.3 hours respectively. This is less than 10% of the time that would be required for an injury to occur and, therefore, assuming harbour porpoise avoid the injury effects zone, they are not considered to be at risk of any permanent or temporary injury during impact piling. The maximum time that would take seals to leave the PTS and TTS zones is estimated to be 10 minutes and 1.2 hours respectively. This is less than 5% of the time that would be required for an injury to occur and, therefore, assuming seals evade the injury effects zone, they are not considered to be at risk of any permanent or temporary injury during impact piling.

9.8.191 Assuming a worst case of a lower swimming speed of 1.5 m/s for all marine mammal species (including both adults and juveniles), the maximum time that would take harbour porpoise to leave the centre of the cumulative SEL weighted PTS and TTS injury zones during vibro piling is estimated to be 1 minute and 14 minutes respectively. This is less than 1% of the time that would be required for an injury to occur and, therefore, assuming harbour porpoise evade the injury effects zone, they are not considered to be at risk of any permanent or temporary injury during vibro piling. The maximum time that it would take seals to leave the PTS and TTS zones is estimated to be 29 seconds and 6 minutes respectively. This is less than 0.4% of the time that would be required for an injury to occur and, therefore, assuming seals evade the injury effects zone, they are not considered to be at risk of any permanent or temporary injury during vibro piling.

9.8.192 Impact piling is predicted to have the potential to cause instantaneous injury effects within close proximity to the activity and strong behavioural responses over a wider area although this will be constrained to within the outer section of the Humber Estuary between Hull and Cleethorpes.

9.8.193 The results indicate that if any marine mammals present in the Humber Estuary were to remain stationary within the cumulative SEL distances from the source of piling over a 24 hour period, it could result in temporary and/or

permanent hearing injury. However, it is considered highly unlikely that any individual marine mammal will in fact stay within this “injury zone” during the piling operations.

9.8.194 Any marine mammals present are likely to avoid the area. Behavioural responses could include movement away from a sound source, aggressive behaviour related to noise exposure (e.g. tail/flipper slapping, fluke display, abrupt directed movement), visible startle response and brief cessation of reproductive behaviour (Southall *et al*., 2007). Mild to moderate behavioural responses of any individuals within these zones could include movement away from a sound source and/or visible startle response (Southall *et al*., 2007).

9.8.195 Any evasive response could also lead to the potential temporary avoidance of the outer section of the Humber Estuary between Hull and Cleethorpes. There is therefore considered the potential for the restriction of the movements of marine mammals upstream and downstream (i.e., a barrier to movements). The Humber Estuary upstream of the proposed development is not known to be used as a breeding site for seals (with the nearest known breeding colony located over 25 km away at Donna Nook at the mouth of the estuary). However, seals and harbour porpoise are frequently recorded foraging in the Humber Estuary. Any barrier to movements caused by the noise during piling, however, would be temporary with significant periods during a 24-hour period when no piling will be undertaken (see below). This of itself will allow the unconstrained movements of marine mammals through the Humber Estuary. It should also be noted that marine mammals are also highly mobile and wide ranging and, therefore, are likely to be able to exploit other areas for foraging during any piling.

9.8.196 The effects of piling noise on marine mammals also need to be considered in terms of the duration of exposure. Piling noise will take place for a very small amount of time each day over a period of approximately 24 or 37 weeks (depending on whether a sequenced construction is employed). Piling will not take place continuously as there will be periods of downtime, pile positioning and set up.

9.8.197 The piling works will be undertaken Monday to Sunday. At present, the maximum impact piling scenario is for 4 tubular piles to be installed each day from either front (i.e. the land and water), involving approximately 180 minutes of impact piling per day and 20 minutes of vibro piling per day. There will, therefore, be significant periods over a 24-hour period when marine mammals will not be disturbed by any piling noise. The actual proportion of impact piling is estimated to be at worst around 14% (based on 180 minutes of impact piling and 20 minutes of vibro piling each working day) over any given construction week. In other words, any marine mammals that remain within the predicted behavioural effects zone at the time of percussive piling will be exposed a maximum of up to 14% of the time.

9.8.198 It is also important to consider the noise from piling against existing background or ambient noise conditions. The area in which the construction will take place already experiences constant vessel operations and ongoing maintenance dredging, and, therefore, marine mammals are likely to be habituated to a certain level of anthropogenic background noise.

9.8.199 Applying the standard impact assessment criteria in the assessment, the probability of occurrence of underwater noise disturbance during piling is high. The magnitude of the change is, however, considered likely to be small to medium, taking account of the scale of change, short term and temporary nature of the piling works and highly mobile nature of marine mammals. The sensitivity of marine mammal species to piling noise is considered to be moderate[26] . In addition, the importance of marine mammal species is considered to be high given the level of protection that they are afforded. As a consequence, the temporary underwater noise effect on marine mammals during piling is assessed as **minor to moderate adverse**.

Project impact assessment: Capital dredge and dredge disposal

9.8.200 The distances at which PTS, TTS and behavioural effects in marine mammals in the study area are predicted to occur as a result of the dredging and vessel movements to and from the disposal sites associated with the proposed development are included in Appendix 9.2 to this ES.

9.8.201 NOAA's user spreadsheet tool (NOAA, 2021) has been used to predict the range at which the weighted cumulative SEL acoustic thresholds (NOAA, 2018) for PTS and TTS are reached during the proposed dredging and disposal activity based on the assumptions highlighted in Appendix 9.2 to this ES.

9.8.202 There is predicted to be no risk of PTS in harbour porpoise and the risk of TTS is limited to within less than 44 m from the dredging or vessel activity. There is predicted to be no risk of PTS in seals and the risk of TTS is limited to within 12 m from the source.

9.8.203 Overall, there is not considered to be any risk of injury or significant disturbance to marine mammals from the proposed dredging and vessel activities that are proposed at the Port of Immingham even if the dredging and vessel movements were to take place continuously 24/7.

9.8.204 The probability of a change in underwater noise occurring during dredging and dredge disposal is high. However, hearing damage is unlikely to occur and the main effect that could be expected in the vicinity of the dredge vessels would be short-term mild behavioural avoidance. Based on these factors, the magnitude of the change due to dredging noise is considered to be negligible and the sensitivity of marine mammals to dredging noise is

[26] Moderate sensitivity was assigned on the basis that relatively localised injury effects (and behavioural responses over a wider area) are predicted from the anticipated level of underwater noise generated by the piling. However, the zones of potential injury and behavioural responses would be expected to be lower than for other activities such as the percussive piling of larger offshore tubular piles, seismic survey or blasting operations.

considered to be low. Taking these factors into account, the overall exposure and vulnerability of marine mammals will be negligible and none respectively. Overall, therefore, the impacts of dredging noise on all marine mammals is considered to be **insignificant.**

Coastal waterbirds

9.8.205 This section contains an assessment of the potential impacts to coastal waterbird receptors as a result of the construction phase of the IERRT project. The following impact pathways have been assessed:

- Loss or change to coastal waterbird habitat (paragraphs 9.8.207 to 9.8.219); and
- Noise and visual disturbance (paragraphs 9.8.220 to 9.8.252).

9.8.206 As noted above, the construction of the IERRT project may be completed in a single stage, or it may be sequenced such that the construction of the southernmost pier takes place at the same time as operation of the northernmost pier (see Chapter 3 of this ES). In the case of a sequenced construction, the duration of construction will be extended with both construction and operational disturbance stimuli potentially occurring concurrently. As described in paragraphs 9.8.289 to 9.8.300 below, potential disturbance in operation is expected to be relatively limited given the nature of the activities and expected habituation. Therefore, construction activity during the sequenced construction would be expected to be more disturbing (i.e., elicit disturbances responses at greater distances and more frequently) than operational activity. On this basis, waterbirds are likely already to have reacted to construction related disturbance stimuli before any response to operational activity could be triggered. It should be noted, therefore, that the impact pathway assessment set out below is considered the worst case and will not be altered by a sequenced construction period.

Loss or change to coastal waterbird habitat

General scientific context

9.8.207 The quality of intertidal habitat as a feeding resource for waterbirds can be highly variable both spatially and temporally (Mander *et al.,* 2013). Higher energetic costs for waterbirds could occur in areas where habitat change has caused a reduction in prey distribution and density. This may affect local populations in the long-term through impacts on individual fitness (survival, body condition and fecundity) (Bowgen *et al.,* 2016).

9.8.208 Habitat loss can also result in increased densities of birds already using a site, increasing the potential for competition (Santos *et al*., 2005; Bowgen *et al*., 2016). Loss or severe degradation of intertidal habitat could displace birds and cause them to redistribute either locally or to neighbouring sites (Gunnarsson *et al*., 2005). This in turn might affect the birds at those sites through competition and density-dependent mortality. Redshank displaced following the construction of an amenity barrage at Cardiff Bay (South Wales), for example, experienced a poorer body condition and had a lower survival rate after they moved (Burton *et al.,* 2006). Lambeck (1991) found that Oystercatchers displaced following large-scale habitat loss in the Delta

region of The Netherlands experienced significantly higher mortality than those originally ringed elsewhere in the Delta, it is presumed as a result of the increased densities in recipient areas.

Project impact assessment

9.8.209 As noted above, it is anticipated that the proposed development will result in the loss of 0.022 ha of intertidal habitat due to the following direct and indirect effects:

- Capital dredging will potentially cause a direct loss of 0.006 ha of lower shore intertidal habitat which will be changed to subtidal habitat as a result of the deepening;
- The piles will cause a direct loss of 0.006 ha of intertidal mudflat habitat; and
- Capital dredging and marine infrastructure will cause a potential indirect loss of intertidal (0.01 ha) due to erosion caused by changes in currents as described in more detail in the Physical Processes assessment (Chapter 7 of this ES).

9.8.210 The capital dredge will also cause a change in intertidal habitat. It is predicted that 0.003 ha of intertidal habitat will become lower in elevation (i.e. lower in the tidal frame) and steeper in profile due to the slope of the proposed dredge pocket but will remain intertidal habitat.

9.8.211 Potential effects of the predicted habitat loss are described initially followed by the habitat change.

Habitat loss

9.8.212 The combined loss of habitat (0.022 ha) represents approximately 0.000058% of the Humber Estuary SPA/Ramsar[27]. When considering this is the context of intertidal, the area of loss represents approximately 0.000248% of intertidal foreshore habitats[28] and approximately 0.000345% of mudflat[29] within the SPA/Ramsar.

9.8.213 The predicted intertidal losses relating to the capital dredging (direct and indirect) consist of very narrow strips on the lower shore around the sublittoral fringe. These losses are considered to be of a similar scale to that which can occur due to natural background changes in mudflat extent in the local region (e.g., due to seasonal patterns in accretion and erosion or following storm events). The loss of habitat due to piling will also be highly localised. These *de minimis* changes in mudflat extent are of a magnitude that will not change the overall structure or functioning of the nearby mudflats within the Port of Immingham area or more widely in the Humber Estuary.

27 Based on the extents given in the Standard Data Form on the JNCC website (JNCC, 2022b)

28 Based on using the 'Intertidal Substrate Foreshore (England and Scotland)' data layer (https://magic.defra.gov.uk/Metadata_for_MAGIC/SPIRE%20intertidal%20substrate%20foreshore.pdf

29 Based on using mudflat data layer of the Priority Habitat Inventory (England) (https://data.gov.uk/dataset/4b6ddab7-6c0f-4407-946e-d6499f19fcde/priority-habitat-inventory-england).

9.8.214 In terms of functional value, the foreshore in the Port of Immingham area is used by a range of species for feeding including Black-tailed Godwit, Dunlin, Redshank, Shelduck, Oystercatcher, Curlew, Teal and Mallard (Table 9.19 and Table 9.20 of this chapter). Many of these birds feed clustered around the tideline and will follow the tideline as it pushes up and down the shore on flood and ebb tides respectively[30]. These species could therefore be potentially feeding in the predicted areas of habitat loss during low water periods. However, both the predicted direct and indirect areas of intertidal habitat loss are only exposed during low water spring tidal phases (remaining underwater during neap tidal phases) under current (pre-dredge) conditions. As a consequence, these very small areas already largely remain inundated with water and are only uncovered for a very short duration.

9.8.215 To put this into context, consideration has been given to the proportion of time that the areas of loss are available to feed over the course of a year. Based on tide gauge data at Immingham in 2020, the areas of both direct (due to the capital dredge deepening and piling) and indirect loss (as a result of potential erosion) were completely submerged for 99% of the time. These areas of loss, therefore, currently provide almost no feeding opportunities for coastal waterbirds. Furthermore, the spatial extent of losses represent a barely measurable and inconsequential reduction in available habitat for these mobile species even at a local scale.

9.8.216 On this basis, it can be concluded that any change to prey resources for birds feeding in the local area will be negligible and individual survival rates or local population levels (either directly through mortality or due to birds dispersing to new feeding areas in other areas of the Humber Estuary) will not be affected.

Habitat change

9.8.217 A very small area of lower shore intertidal habitat at the top edge of the dredge slope will become steepened and slightly lower in the tidal frame as a result of the dredging (0.003 ha). The habitat change represents approximately 0.000008% of the Humber Estuary SPA/Ramsar. When considering this in the context of intertidal, the area of change represents approximately 0.000034% of intertidal foreshore habitats[31] and approximately 0.000047% of mudflat[32] within the SPA.

30 Wading birds can often concentrate their foraging efforts in newly exposed or covered areas during ebbing and rising tides (when sediments were wet or still covered by a thin layer of water). It is thought that that moving tidal waterline briefly creates particular suitable conditions for waders (invertebrates move deeper in the substate or become less as the tide falls and the substrate dries (as well as showing less surface cues) (Granadeiro *et al*., 2006; Pienkowski, 1983).

31 Based on using the 'Intertidal Substrate Foreshore (England and Scotland)' data layer (https://magic.defra.gov.uk/Metadata_for_MAGIC/SPIRE%20intertidal%20substrate%20foreshore.pdf

32 Based on using mudflat data layer of the Priority Habitat Inventory (England) (https://data.gov.uk/dataset/4b6ddab7-6c0f-4407-946e-d6499f19fcde/priority-habitat-inventory-england).

9.8.218 Habitat change at this *de minimis* scale is in the range of local natural variability and is expected to be immeasurable in real terms when taking account of the variation in water levels, wave climate and accuracy of the modelled bathymetry. Any changes in infaunal composition (including prey items) due to the lowering in elevation in this area will be highly localised with key characterising species likely to be similar[33]. Furthermore, in reality this *de minimis* area represents an inconsequential change for these mobile species even at a local scale. The location of this change on the lower shore (near the sublittoral fringe) means that any change to the area exposed at each state of the tide for birds to feed or any reduction in the potential time available for feeding within this area will be negligible[34]. On this basis the overall functioning of the mudflat in the area and the prey resources available to coastal waterbirds will not be affected and will not cause a change in bird distribution.

9.8.219 Based on the evidence provided above, the probability of habitat loss and change occurring is high, albeit minimal, but the magnitude of potential impacts is considered to be negligible. Exposure to change is, therefore, negligible. Local populations of waterbirds are considered to have a low sensitivity to the scale of habitat loss and change predicted. On this basis, vulnerability is assessed as none. Importance is high given the protection afforded to the supporting habitats and bird species in the area of predicted loss. On this basis, the impact is assessed as **Insignificant**.

Noise and visual disturbance

General scientific context

Introduction

9.8.220 Disturbance can cause birds to cease feeding, which can decrease the total amount of time available for feeding, as well as disrupting other behaviour such as breeding (Coleman *et al.*, 2003; Martín *et al.*, 2014). Where disturbance causes birds to take flight, it can increase energy demands and may increase food consumption by decreasing the available habitat area (Goss-Custard, 2020; Linssen *et al.*, 2019; Stillman *et al.*, 2007). Repetitive disturbance events can result in possible long-term effects such as loss of weight, condition and a reduction in reproductive success, leading to population impacts (Durell *et al.*, 2005; Goss-Custard *et al.*, 2006; Belanger and Bedard, 1990). Birds typically show a dispersive response to disturbance with prolonged disturbance causing displacement (Goss-Custard, 2020; Dwyer, 2010; Navedo and Herrera, 2012).

[33] The key commonly recorded species recorded on the foreshore in the project-specific intertidal benthic surveys included waterbird prey items such as the bivalve *Limecola balthica*, mudshrimp *Corophium volutator* and ragworm *Hediste diversicolor*. These are found at a range of shore heights from the sublittoral fringe to the upper shore and are considered relatively tolerant to changes in emergence which do not alter the extent of the intertidal (Ashley and Budd, 2020; Tillin and Rayment, 2016).

[34] Based on tide gauge data at Immingham in 2020, the area of change was completely submerged during the 12-month period for 99 % of the time.

9.8.221 Disturbance often occurs through a combination of simultaneous visual and noise stimuli, although some occurrences may be through separate visual or noise stimuli (Wright *et al.*, 2013). Birds will also vary their response to human activities depending on the type of the activity, the noise produced, the speed and randomness of approach, the distance to which the disturbance factor approaches and the frequency of disturbance (Burton *et al*., 2002a., Rees *et al*., 2005; Liley *et al*., 2010; Coleman *et al.*, 2003; Ruddock and Whitfield, 2007; Stillman *et al.*, 2012).

Disturbance responses associated with construction activity

9.8.222 Construction activity in the coastal zone may lead to disturbance which has the potential to cause a reduction in foraging activity as well as temporary displacement from a localised area around the works (Burton *et al.*, 2002a).

9.8.223 Overall, responses to construction noise and activity appear to initiate similar or less disturbance than that of human presence on the foreshore (e.g. recreation) (ERM, 1996; ABPmer, 2013; IECS, 1997; IECS, 2013). For example, while some localised disturbance was caused as a result of piling activity as part of the construction work for ABB Power Generation Ltd (Pyewipe, Grimsby), this was not considered to have a major effect on surrounding bird populations and was found to be no greater than the effect arising from third party disturbance, including walkers and stopped cyclists, which were unrelated to the ABB works (ERM, 1996). The greater effect of human presence as opposed to general construction works and machinery is also supported by IECS (1997), in that a person approaching feeding birds on the mudflat caused birds to fly when the person was approximately 300 m from the birds, whereas machinery could approach birds up to 50 m before the birds moved away.

9.8.224 Lower levels of disturbance for construction activities compared with other nearby human activity was also observed during bird monitoring as part of the marine licensing consent for a quay wall construction development at the Port of Southampton. The study evaluated the disturbance effects of the extension work on waterbird species using the mudflat habitat on Bury Marsh opposite the Port of Southampton (approximately 100 to 200 m away) during the overwinter period. No bird disturbance behaviour (such as startling, rapid flight or abruptly stopping foraging) was observed during periods of percussive piling activity. However, disturbance to waterbirds was observed on several occasions due to vessels and kayaks within 50 m of Bury Marsh (ABPmer, 2013).

9.8.225 Studies into the distances from activities that evoke a disturbance response (or FID) suggest that for most coastal works and other foreshore activity in areas where birds are likely to be habituated to some extent to disturbance due to existing anthropogenic activity, disturbance behaviour is not typically observed when activities occur more than some 200 m away from a source with the reactions of many species occurring between 20 and 100 m (ABPmer, 2002; Ruddock and Whitfield, 2007; IECS, 2009a; Wilson, 2009; IECS, 2009b; Dwyer, 2010; IECS, 2013; Ross and Liley, 2014; Collop *et al*., 2016; Goodship and Furness, 2019; Goodship and Furness, 2022; ABPmer,

2013). This is discussed in more detail below in paragraphs 9.8.228 and Table 9.23.

9.8.226 Construction techniques which are known to cause loud source noise levels (such as piling) have been the subject of a number of disturbance monitoring studies which have investigated the relationship between activity source levels and the disturbance responses elicited by birds (IECS, 2009a; Xodus, 2012; Wright *et al.*, 2013; ABPmer, 2002; IECS, 2013). Research suggests that irregular construction noise at levels typically above 70 dB can cause behavioural responses in some waterbird species with flight responses generally occurring above 80 dB (Table 9.22). However, responses of birds will be dependent on a range of site-specific factors including ambient (background) noise levels, time of year, levels of existing activity and the species assemblage. In addition, visual disturbance associated with construction activity will often create a disturbance effect before any associated noise starts to have an effect (IECS, 2013).

Table 9.22. Summary of noise disturbance studies

Study	Summary
IECS, 2009a; IECS, 2009b	A study of coastal construction noise effects on the Humber Estuary was undertaken based around the measurement of noise levels while simultaneously monitoring the behavioural response by birds during flood defence works at Saltend. The defence works involved the use of a double hydraulic pile on site. The study noted a moderate to high behavioural response to irregular piling noise above 70 dB and a moderate response to regular piling noise below 70 dB. A flight response was noted to occur during works generating noise at between 80-85 dB. Behavioural responses, notably the down-shore movements of wildfowl were noted above 70 dB. Noise levels between 55 dB and 84 dB were generally accepted by birds. Other impacts associated with construction included a high response to personnel and plant equipment on the mudflat and a moderate to high response to personnel and plant equipment on the seaward toe and crest. Occasional movement of a crane jib and load resulted in a low to moderate response. Noises below 50 dB, long-term plant activities only on the crest and activity behind the flood bank elicited a low response.
Xodus, 2012	Monitoring of birds as part of the Grimsby River Terminal Project found that noise from construction (including piling) caused only 1% of the disturbance events observed, with large disturbances mainly caused by the presence of raptors, aircraft and helicopters. The study concluded that percussive piling noise less than 66 dB LA_{max} F gave rise to no disturbance, whilst a mild behavioural response (such as heads up alert, short walk or swimming) was observed to occur in the range of 73 to 81 dB LA_{max} F. Percussive piling noise over 83 dB LA_{max} F was considered likely to evoke a flight response.

Study	Summary
Wright *et al.,* 2013	The experimental study intentionally disturbed birds at a high tide roost site, on the south bank of the Humber estuary using an impulsive sound similar to that associated with noise from port and power generation construction such as percussive piling and recorded the behavioural responses. Lapwing appeared to be the species most sensitive to intentional disturbance, while Curlew was the most tolerant. The study recommended that impulsive noise limits should be restricted to < 69.9 dB at the site.
ABPmer, 2002	Disturbance monitoring of waterbirds in the vicinity of construction works (piling and dredging) at the ABP Teignmouth Quay Development concluded that sudden noise in the region of 80 dB appears to elicit a flight response in waders up to 250 m from the source, with levels of approximately 70 dB causing flight or anxiety behaviour in some species.

9.8.227 Birds generally appear to habituate to continual noises as long as there is no large amplitude 'startling' component (Hockin *et al.*, 1992). With specific respect to piling, it has been concluded that although piling has the potential to create most noise during construction it often consists of rhythmic "bangs", which birds might become accustomed to depending on the distance that birds are away from the piling (ABP Research, 2001). For example, observations as part of the construction work for ABB Power Generation Ltd (Pyewipe) suggested that it was the initial sudden bang during piling activities, which caused some localised disturbance, and that subsequent bangs typically resulted in reduced disturbance, demonstrating habituation (ERM, 1996).

Species sensitivity and responses

9.8.228 The level of response to potential disturbance stimuli also varies considerably between species with some ducks (such as Shelduck) and larger waders such as Curlew, Grey Plover and godwits generally showing stronger responses to disturbance stimuli than smaller waders (such as Turnstone and Dunlin) (Collop *et al*., 2016; Goodship and Furness, 2022; Calladine *et al*., 2006; IECS, 2013; Goodship and Furness, 2019; Davidson and Rothwell, (1993). A detailed review of the responses and sensitivity of key waterbird species to noise and visual disturbance is presented in Table 9.23. This includes data on flight initiation distance (FID) which is the distance at which a bird takes flight in response to a perceived danger and is used to help better understand the relative sensitivity of different species to disturbance.

9.8.229 The response to disturbance is also dependant on the previous experience of the birds to disturbance (i.e. level of habituation) as well as a range of other factors such as environmental conditions, their state at the time of the disturbance (e.g. hungry or satiated) and the quality of their alternative foraging sites (Gill *et al.*, 2001a; Mullner *et al.*, 2004; IECS, 2009a; Collop *et al.* 2016).

9.8.230 It is also important to understand potential behavioural responses of disturbance in the context of energetic costs, mortality and population consequences as some disturbance has been shown to have limited adverse effects on waterbirds. For example, Goss-Custard *et al*. (2006) used an individual-based behavioural model to establish critical thresholds for the frequency with which wading birds can be disturbed before they die of starvation. The model was tested on oystercatchers in the Baie de Somme, France, where birds were put to flight by disturbance up to 1.73 times/daylight hour. The modelling results showed that the birds could be disturbed up to 1.0 to 1.5 times/h before their fitness was reduced in winters with good feeding conditions (abundant cockles and mild weather) but only up to 0.2 to 0.5 times/h when feeding conditions were poor (scarce cockles and severe winter weather).

Table 9.23. Summary of evidence of the sensitivity for different key species to noise and visual disturbance stimuli

Species	Sensitivity to noise and visual disturbance	
	Evidence on the sensitivity to disturbance stimuli	Sensitivity level[1]
Shelduck	Shelduck are generally a wary species and are considered particularly sensitive to visual disturbance. Typically, they approach construction works no closer than 300 m and can be affected by visual disturbance up to 500 m away from source (IECS, 2013). Noise disturbance has been reported from 72 dB upwards for Shelduck. However, the species is subject to a high degree of habituation and further exposure to sounds of the same or greater level can lead to no response to stimuli. No response has been recorded for noise levels as high as 88 dB, but this is likely to be an extreme 'no response' level and caution should be exercised at receptor levels over 70 dB. Observation of disturbance responses from flood protection works has suggested that Shelduck react to noise in approximately 30% of exposure events to sudden noise above 60 dB or any noise above 70 dB (IECS, 2013). Goodship and Furness (2022) assessed Shelduck as having a high sensitivity to human disturbance with the range in mean FID from the literature reviewed of 36 m to 250 m as a result of the presence of people on or near the foreshore although FIDs up to 700 m have been recorded. Goodship and Furness (2019) undertook a disturbance literature review and assessed Shelduck as one of the species considered most sensitive to disturbance stimuli with the range in mean FID from the literature reviewed of 148 m to 250 m as a result of the presence of people on or near the foreshore.	Moderate to high
Curlew	Research evidence indicates that Curlew are a cautious species that does not habituate to works rapidly and are also particularly intolerant of people, allowing approach to a range of typically 120-300 m before flushing (IECS, 2013; Lausen *et al,* 2005). Goodship and Furness (2022) assessed Curlew as having a high sensitivity to human disturbance with the with the range in mean FID from the literature reviewed of 38 m to 340 m as	Moderate to high

Species	Sensitivity to noise and visual disturbance	
	Evidence on the sensitivity to disturbance stimuli	Sensitivity level[1]
	a result of the presence of people on or near the foreshore with motorised vessels having a mean FID of 140 m and motorised vehicles 188 m. Collop *et al., (*2016) recorded a minimum FID of 88 m and a maximum FID of 570 m (with a mean of 340 m) for this species through experimentally disturbing foraging birds (approaching a total of 39 times) as part of a research study. Goodship and Furness (2019) undertook a disturbance literature review and assessed Curlew as one of the species considered most sensitive to disturbance stimuli with the range in mean FID from the literature reviewed of 38 m to 340 m as a result of the presence of people on or near the foreshore with motorised vessels having a mean FID of 140 m.	
Black-tailed Godwit	Data on the responses of Black-tailed Godwit to disturbance in the UK is limited although disturbance responses have been recorded within 100-250 m of construction activity (IECS, 2013). Goodship and Furness (2022) found evidence of FIDs between 20 and 150 m as a result of presence of people on or near the foreshore from the literature reviewed in the study.	Moderate to high
Bar-tailed Godwit	Bar-tailed Godwit can be a relatively disturbance tolerant species that habituates to works rapidly (allowing an approach range of as close as 40-100 m before flushing). However, despite this tolerance, Bar-tailed Godwits can abandon highly disturbed areas in favour of quieter areas to forage and roost. For example, direct observation of disturbance responses by the species to flood defence works found the species did not forage within 200 m of the activity, despite foraging being actively pursued beyond this range, suggesting that they had actively vacated the area close to the works. This is consistent with previous research findings (IECS. 2013). Collop *et al., (*2016) recorded a minimum FID of 32 m and a maximum FID of 225 m (with a mean of 84 m) for this species through experimentally disturbing foraging birds (approaching a total of 92 times) as part of a research study. Goodship and Furness (2019) and Goodship and Furness (2022) undertook disturbance literature reviews and assessed Bar-tailed Godwit as being of moderate sensitivity to disturbance stimuli	Moderate

Species	Sensitivity to noise and visual disturbance	
	Evidence on the sensitivity to disturbance stimuli	Sensitivity level[1]
	with the range in mean FID from the literature reviewed of 22 m to 219 m as a result of the presence of people on or near the foreshore.	
Oystercatcher	Oystercatchers are relatively tolerant of disturbance stimuli and will habituate rapidly to ongoing activity. In undisturbed areas they will often flush at great ranges but in more disturbed locations such as a typical estuary, this figure reduces to typically between approximately 25-200 m dependent upon the stimuli (with people causing the most extreme reaction) (IECS, 2013). Collop *et al., (*2016) recorded a minimum FID of 30 m and a maximum FID of 228 m (with a mean of 97 m) for this species through experimentally disturbing foraging birds (approaching a total of 147 times) as part of a research study. Goodship and Furness (2019) and Goodship and Furness (2022) undertook disturbance literature reviews and assessed Oystercatcher as being of moderate sensitivity to disturbance stimuli with the range in mean FID from the literature reviewed of 26 m to 136 m as a result of the presence of people on or near the foreshore with motorised vessels having a mean FID of 74 m and motorised vehicles a mean FID of 106 m.	Moderate
Redshank	Redshank are considered a relatively tolerant species to visual stimuli (and will often approach much closer than 100 m before flushing (sometimes as close as 30-50 m)) but can be sensitive to noise stimuli. They are also considered to habituate to works rapidly (IECS, 2013). Collop *et al., (*2016) recorded a minimum FID of 28 m and a maximum FID of 187 m (with a mean of 80 m) for this species through experimentally disturbing foraging birds (approaching a total of 53 times) as part of a research study. Goodship and Furness (2022) assessed Redshank as having a moderate sensitivity to human disturbance with the range in mean FID from the literature reviewed of 4 to 150 m as a result of the presence of people on or near the foreshore.	Low to moderate

Species	Sensitivity to noise and visual disturbance	
	Evidence on the sensitivity to disturbance stimuli	Sensitivity level[1]
	Goodship and Furness (2019) undertook a disturbance literature review and assessed Redshank as being relatively sensitive to disturbance stimuli with the range in mean FID from the literature reviewed of 24 m to 137 m as a result of the presence of people on or near the foreshore.	
Knot	Knot appear to be a species relatively tolerant to visual stimuli and are considered to habituate relatively rapidly to people although disturbance responses have been recorded within <75-100 m of visual stimuli. However, Knot are considered quite sensitive to noise stimuli, especially in conjunction with visual stimuli. Knot have been recorded foraging close to plant (<50 m) and to workers (>75 m), (IECS, 2013). Collop *et al., (*2016) recorded a minimum FID of 20 m and a maximum FID of 240 m (with a mean of 72 m) for this species through experimentally disturbing foraging birds (approaching a total of 78 times) as part of a research study. Goodship and Furness (2022) assessed Knot as having a moderate sensitivity to human disturbance with the range in mean FID from the literature reviewed of 21 to 74 m as a result of the presence of people on or near the foreshore with motorised vessels having a mean FID of 200 m.	Low to moderate
Mallard	Mallard are considered a relatively tolerant species and will habituate rapidly to activity with most responses considered to occur within 200 m or less. There is very little information on the effects of noise disturbance on Mallard but direct disturbance observation of piling recorded two incidents of Mallards reacting to noise (heads-up response) at levels of 69 dB and 71 dB although higher noise generation instances c. 80 dB had no observed response to loafing and foraging birds in a moderately 'noisy' tidal freshwater site on a busy navigation (IECS, 2013). Goodship and Furness (2019) and Goodship and Furness (2022) undertook disturbance literature reviews and assessed Mallard as being of moderate sensitivity to disturbance stimuli with the range in mean FID from the literature reviewed of 13 m to 236 m as a result of the presence of people on or near the foreshore with motorised vessels having a mean FID of 110 m.	Low to moderate

Species	Sensitivity to noise and visual disturbance	
	Evidence on the sensitivity to disturbance stimuli	Sensitivity level[1]
Dunlin	Dunlin appear to be a species relatively tolerant to visual stimuli and are considered to habituate to people with most responses occurring in <75-100 m of visual stimuli. Dunlin have been recorded foraging extremely closely to plant (<50 m) and >75 m from worker. When foraging, they can be initially disturbed by activity start-up, with a flight response, but will then forage back towards construction works, approaching to within 25 m on occasion, before sometimes flushing and moving away again, to repeat the process (IECS, 2013). Collop *et al., (*2016) recorded a minimum FID of 9 m and a maximum FID of 194 m (with a mean of 44 m) for this species through experimentally disturbing foraging birds (approaching a total of 117 times) as part of a research study (IECS, 2013). Goodship and Furness (2019) and Goodship and Furness (2022) undertook disturbance literature reviews with the evidence reviewed suggesting that Dunlin is less sensitive to disturbance than many other waders with the range in mean FID from the literature reviewed of 39 m to 163 m as a result of the presence of people on or near the foreshore.	Low
Turnstone	Turnstone are considered not very sensitive to noise stimuli and habituate rapidly, especially in conjunction with visual stimuli. They are tolerant of people/workers and plant, allowing approach as close as 30-50 m before flushing. Direct observation of disturbance effects from works found Turnstone responses to be consistent with the expected high tolerance, with birds allowing approach to works to within 10 m before reacting. This was in a highly disturbed area with much public use of the foreshore and of 127 potential disturbance events observed, only 19 caused reaction of which only 3 were caused by the works with trucks flushing Turnstones at between 15-100 m. Walkers (and dog walkers in particular) caused the greatest reactions. There was no evidence of reactions to noise, which reached levels above 90 dB due to piling (IECS, 2013). Collop *et al.,* (2016) recorded a minimum FID of 5 m and a maximum FID of 75 m (with a mean of 32 m) for this species through experimentally disturbing foraging birds (approaching a total of 40 times) as part of a research study.	Low

Species	Sensitivity to noise and visual disturbance	
	Evidence on the sensitivity to disturbance stimuli	Sensitivity level[1]
	Goodship and Furness (2019) undertook a disturbance literature review with the evidence suggesting that Turnstone is less sensitive to disturbance than many other waders with the range in mean FID from the literature reviewed of 12.5 m to 39 m as a result of the presence of people on or near the foreshore.	
Ringed Plover	Ringed Plover are considered to be tolerant species to disturbance that habituates to anthropogenic activities rapidly and appear not to be very sensitive to noise or visual stimuli (often allowing approach as close as 30-50 m to workers/people or plant before flushing) (Lausen *et al,* 2005; IECS, 2013). Research has found that at distances of over 100 m from activity, birds rarely showed any sign of disturbance and appeared often unperturbed when other species in their vicinity were reacting (IECS, 2013). Collop *et al.,* (2016) recorded a minimum FID of 29 m and a maximum FID of 74 m (with a mean of 41 m) for this species through experimentally disturbing foraging birds (approaching a total of 30 times) as part of a research study.	Low

1. The assigned sensitivity levels have been based on available evidence with respect to responses to disturbance stimuli. For some species a range in sensitivity has been presented where evidence suggests large variations in intraspecific responses due to various factors which could influence sensitivity (such as the type of activity, site specific factors such as habituation, environmental conditions and site fidelity etc). Where information is limited a precautionary sensitivity level has been assigned.

9.8.231 Collop *et al.* (2016) looked into the likely consequences of different frequencies of disturbance on various wading birds, using their data on mean flight time and mean total time lost. The authors found that a 5% reduction in birds' daily available feeding time would be expected to result from responding to between 38 and 162 separate disturbance events (depending on species and tidal stage). The mean cost per individual flight response represented less than a tenth of a per cent of each species' daily energy requirements. The study concluded that the energetic costs of individual disturbance events, were low relative to daily requirements and unlikely to be frequent enough to seriously limit foraging time.

Review summary

9.8.232 Within the construction site, the level of disturbance stimuli is dependent on the type of activity being undertaken. In general, human presence on or near the foreshore (e.g., walking) is considered to cause greater disturbance than vehicles or watercraft and waterbirds are more easily disturbed by irregular movements than the regular and defined presence of machinery, vessels and other vehicles (IECS, 1997; ABPmer, 2013; McLeod, *et al.* 2013; Guay *et al.* 2014; Glover *et al.* 2015). High level responses to noise (such as dispersal away from marine works) are typically associated with sudden or irregular noise over 70-80 dB (at the receiver (i.e. bird) location not the noise source) (IECS, 2009a; Xodus, 2012; Wright *et al*., 2013; ABPmer, 2002; IECS, 2013).

9.8.233 The specific responses that waterbirds will have to disturbance varies between species as well as between birds of the same species due to a range of factors including the level of habituation and environmental conditions (Gill *et al.,* 2001a; Mullner *et al.,* 2004; IECS, 2009a; Collop *et al.* 2016).

9.8.234 Distances over 300 m have been recorded more occasionally for some sensitive species such as Curlew or Shelduck (IECS, 2013; Collop *et al*. 2016; Goodship and Furness, 2019; Goodship and Furness, 2022). However, evidence from the detailed review above suggests, that waterbirds generally show a flight response to anthropogenic activities such as construction and a presence of people (such as workers) on or near the foreshore at distances of typically less than 200 m (and more typically between 20 m and 100 m for certain species such as Turnstone or Dunlin) in areas where birds are likely to be habituated to some extent to disturbance due to existing human activity (ABPmer, 2002; Ruddock and Whitfield, 2007; IECS, 2009a; Wilson, 2009; IECS, 2009b; Dwyer, 2010; IECS, 2013; Ross and Liley, 2014; Goodship and Furness, 2022; Collop *et al*., 2016; Goodship and Furness, 2019; ABPmer, 2013).

Project impact assessment: Ro-Ro terminal (construction and capital dredging)

9.8.235 The bird data suggest that the foreshore fronting the proposed development (i.e., the section of Sector B effectively representing the eastern half of the port's frontage between the Inner Dock entrance and IOT Jetty) is regularly used by 500 to 800 birds for feeding during the winter months with the species recorded in the largest numbers including Black-tailed Godwit,

Dunlin, Redshank, Shelduck, Turnstone and Curlew. Other species recorded include Bar-tailed Godwit, Knot, Oystercatcher, Ringed Plover, Teal and Mallard (Figure 9.10, Table 9.19 and Table 9.24 to this ES)[35]. It should be noted that data collected in passage months recorded broadly similar peak counts of Black-tailed Godwit, Redshank, Curlew, Oystercatcher and Turnstone and generally lower numbers of other species such as Dunlin and Shelduck (Table 9.20).

Table 9.24. The 5-year mean peak (2017/18 to 2021/22) for key species of birds in Sector B and% of the mean peak as a proportion of the current estuary-wide WeBS 5-year mean peak.

Species	Mean Peak	Mean peak as a% of the current estuary-wide WeBS 5-year mean peak [1]
Bar-tailed Godwit	15	< 1%
Black-tailed Godwit	574	13%
Cormorant	13	4%
Curlew†	12	< 1%
Dunlin	387	2%
Knot	8	< 1%
Mallard†	5	< 1%
Oystercatcher†	9	< 1%
Redshank	171	6%
Ringed Plover†	5	< 1%
Shelduck	76	2%
Teal†	14	< 1%
Turnstone†	29	12%

SPA qualifying species highlighted in **bold.** † Species with this symbol are included within the SPA waterfowl assemblage.

1. The latest Humber Estuary WeBS Core Counts 5-year average from 2015/16 to 2019/20 (Frost *et al*., 2021) has been used in this assessment. It should be noted that as a result of COVID-19 lockdowns, the BTO were unable to undertake comprehensive counts and therefore produce robust data for 2020/21 at an estuary-wide scale and therefore the period 2015/16 to 2019/20 is the most recent 5 years of data available from the BTO.

35 The highest densities of feeding and roosting birds in Sector B typically occur on the intertidal mudflats in the eastern section of the foreshore fronting Immingham Docks (from the lock gate towards the IOT Jetty). Very low numbers of waterbirds have been recorded west of the lock gate with flocks of Turnstone (which often show a preference for the sea defence/mud interface in this area) and occasional individuals of Dunlin, Curlew and Redshank recorded. It should also be noted that the foreshore to the east of the IOT jetty within approximately 300 m of the proposed development is used by very low numbers of birds based on data collected as part of the IOH ornithological monitoring of Sector C (which overlaps with this area). Observations from these surveys has recorded typically less than a total of 10 birds with individuals or small flocks of mainly Redshank, Curlew and Oystercatcher occurring.

9.8.236 The evidence reviewed above suggests that the response of waterbirds to disturbance stimuli is relatively limited at distances over 200 m, particularly in areas subject to already high levels of existing anthropogenic activity (as found in the Port of Immingham area).

9.8.237 With specific respect to noise stimuli, Natural England provided advice as part of the consultation for the IERRT project which stated that '*peak levels below 55 dBA can be regarded as not significant, while peak noise levels approaching 70 dBA and greater are most likely to cause an adverse effect.' Therefore, levels over 65.5 dBA may cause disturbance to SPA birds. Birds may habituate to regular noise below 70 dBA, but irregular above 50 dBA should be avoided*'. It is also worth noting that visual disturbance associated with anthropogenic activity will in some situations create a disturbance effect before any associated noise starts to have an effect particularly in those species sensitive to visual stimuli (McLeod *et al.,* 2013; Smit and Visser, 1993; IECS, 2013).

9.8.238 Ambient noise levels on the foreshore around the Port of Immingham are shown in Table 14.20 in the Noise and Vibration assessment (Chapter 14) of this ES. Unattended noise measurements over five days in July 2022 suggest a range of 42 to 58 dB *L*Aeq,1 hr and the existing range of *L*max noise levels is 48 to 84 dB *L*max. During percussive piling associated with the proposed development, noise levels above 70 dB *L*max are predicted within approximately 1.8 km of the piling rigs and over 80 dB *L*max within approximately 600 m in the absence of noise reducing controls.

9.8.239 The assessment has been based on consideration of a 200 m potential disturbance zone and noise level guidance provided by Natural England described above.

9.8.240 During construction, disturbance could potentially occur as a result of the following activities:

- Capital dredging:
- Construction of the outer finger pier; and
- Construction of the approach jetty and inner finger pier.

9.8.241 Each one of these activities is described in more detail below. In order to better understand potential zones of disturbance, Figures 9.11 to 9.13 of this chapter present a 200 m buffer zone which is considered relatively precautionary in terms of zones of potential effects. The figures also show MLWS and MLWN so that the extent of foreshore within and outside of these buffers under different tidal states can be better understood.

Capital dredging

9.8.242 Evidence suggests most disturbance events from powered vessels have been recorded within 100 m of the receptor with vessels approaching at faster speeds eliciting higher disturbance (Rodgers and Schwikert, 2002; Burger and Gochfield, 1998; Schwemmer *et al*., 2011; Glover *et al*., 2015). The dredging vessel will be operating at slow speeds when undertaking the

capital dredging. Most capital dredging will be undertaken in the vicinity of the outer berths (approximately 100 to 300 m from the lower shore during low water periods) (Figure 9.11). The near shore environment in the Port of Immingham area is already subject to large numbers of vessel movements including maintenance dredging. Given the distance between the intertidal and the main dredge area and expected existing habituation to vessels operating at this distance from the foreshore, disturbance responses by birds are considered likely to be limited by dredging in this area.

9.8.243 Some capital dredging is also required nearer the intertidal (within approximately 50-100 m). At these distances it is possible that visual and noise stimuli from the dredger (noise levels between 62 and 71 *LA*eq are predicted) could potentially cause disturbance responses. However, this will only be for a short duration of time (<one week) although some localised and intermittent disturbance responses (such as avoidance walking and short flights with birds rapidly resettling and resuming feeding near their original location) is possible. It should be noted that dredging activity is common in this area and to a large extent, the birds will already have become habituated to marine activities. It should also be noted that the existing slope in this area is similar in gradient to the 1 in 4 dredge slope that is proposed for the IERRT project (see Chapter 2 and Chapter 3 of this ES). Furthermore, the amount of material that needs to be dredged within the berth pocket in this location is limited. It is therefore likely that the existing slope will remain stable and will not require further dredging; it is included in the assessment as a worst case.

Construction of the outer finger pier (including connecting pontoon infrastructure)

9.8.244 Noise stimuli caused by the vibro and percussive piling activity and the presence of jack-up or crane barges (causing both potential noise and visual disturbance stimuli) as well as other construction machinery, construction workers and plant activity are all potential sources of disturbance associated with construction of the outer pier.

9.8.245 The construction zone for the outer finger pier including connecting pontoon infrastructure (i.e., outer pontoon and pontoon restraints) will be located approximately 200 m from the lowest part of the foreshore during low water periods (as shown in Figure 9.12 to this chapter). As a consequence, there will at all times be a substantial body of water separating the foreshore from construction activity. This will reduce the perceived threat of disturbance that the birds have to the construction activities. It follows, therefore, that while some disturbance of more sensitive species could occur on the lower shore (when exposed) during this element of the construction, the greater part of the foreshore fronting the Port of Immingham will be at distances of more than 200 m. At this distance, the potential for disturbance responses in even sensitive species is considered to be limited with a large amount of the foreshore still available for feeding at locations and distances in which responses are unlikely to occur. For example, approximately 92% of the foreshore at low water between the Inner Dock entrance and the IOT (which is the mudflat habitat fronting the Port of Immingham supporting the highest

numbers of birds as shown in Figure 9.10 to this chapter) will be at distances of more than 200 m away from the construction zone.

Construction of the approach jetty and inner pier

9.8.246 The approach jetty construction works will overlap directly with a part of the foreshore located close to the IOT jetty. In addition, the inner finger pier (and associated infrastructure such as the bankseat, linkspan and the inner pontoon) are located within approximately 50 to 200 m of the foreshore (Figure 9.13 to this chapter). Noise stimuli caused by the vibro and percussive piling activity and the presence of jack-up or crane barges (causing both potential noise and visual disturbance stimuli) as well as other construction machinery, construction workers and plant activity are all potential sources of disturbance associated with construction of the approach jetty and inner pier.

9.8.247 Waterbirds present in the area will be habituated to some extent to anthropogenic activities (due to existing port operations) near the foreshore such as vessel and vehicle movements, port related noise and human activity. Nevertheless, construction of the approach jetty and inner pier overlaps with some areas of highest bird use on the foreshore within Sector B see Figures 9.10 and 9.13 to this chapter). Avoidance responses or dispersive disturbance events resulting in the redistribution of waterbird flocks to nearby areas may occur relatively frequently for the duration of the construction of these specific elements. On this basis, for species considered more sensitive to bird disturbance such as godwits, Redshank, Curlew and Shelduck (Table 9.23 of this chapter), this could mean that as a worst case a relatively large proportion of the local populations occurring within this area (i.e. recorded in Count Sector B) (as shown in Tables 9.19 and 9.24 of this chapter) could be potentially regularly disturbed or displaced as a result of construction activity associated with the approach jetty and inner finger pier. Less sensitive species such as Dunlin, Turnstone and gulls would be expected to be disturbed to a lesser degree and feed closer to construction activity.

9.8.248 It is not anticipated, however, that birds will be displaced from the local area completely, in that the birds would be expected to redistribute to nearby foreshore in the Immingham area and continue to feed and roost in these alternative locations following dispersal. In this respect, approximately 59% of the foreshore at low water between the Inner Dock entrance and the IOT (which is the mudflat habitat fronting the Port of Immingham supporting the highest numbers of birds as shown in Figure 9.10 to this chapter) will be available at distances of more than 200 m away. In addition, while energetic costs might be increased slightly due to disturbance, the research reviewed above suggests that the energetic costs of individual disturbance events would be expected to be relatively low and even relatively frequent disturbance could potentially only cause a small reduction in the time available in a day for feeding. In addition, birds are known to forage nocturnally and might potentially change foraging patterns to utilise the area during nocturnal periods when limited construction activity is occurring.

9.8.249 It should also be noted that this zone of potential disturbance is also very small in the context of the Humber Estuary SPA/Ramsar. The 200 m buffer, for example only represents 0.023% of the SPA/Ramsar and 0.10% of intertidal foreshore habitats and specifically 0.14% of mudflat within the SPA. Furthermore, most species occur in numbers that represent only a very small proportion of the estuary-wide populations that typically occur. However, it is noted that a greater proportion of the Humber Estuary population of Black-tailed Godwit, Redshank and Turnstone occur in this area on the foreshore and could be disturbed or temporarily displaced (Table 9.24 of this chapter).

9.8.250 It is acknowledged, however, that wintering waterbirds can show a high level of site fidelity and utilise small home ranges (Mander *et al.*, 2022). Site faithful waterbirds birds can sometimes either show reluctance to move to alternative sites or choose the nearest alternative site, despite potentially being of lower quality habitat (e.g., reduced prey resources and also subject to disturbance pressure) when compared to more optimal habitats further away) (Woodward *et al*. 2014; Wright *et al*., 2014; Méndez *et al*, 2018; Burton, 2000). The carrying capacity of adjacent areas of foreshore is inherently difficult to characterise due to the high degree of natural variability (in both prey availability and bird usage) and as such it is recognised that there is a degree of uncertainty as to whether such areas could accommodate displaced birds if this were to occur.

9.8.251 For all the construction activities, it is also recognised that during cold periods, coastal waterbirds are more susceptible to disturbance due to higher energetic costs and greater feeding requirements for thermoregulation. Furthermore, very cold winter weather can cause mudflats and adjacent functionally linked terrestrial habitats used for feeding (such as agricultural land and wet grassland) to freeze. In addition, cold conditions can also cause an influx of waterbirds from continental Europe which have flown to Britain to escape from even colder conditions. This can further increase competition for feeding resources in an area. The increased difficulty obtaining enough food and greater energy required for thermoregulation can in some situations cause reduced survival rates and appear to make birds seem more tolerant to disturbance as birds avoid using excess energy reserves (Goss-Custard, *et al*., 2006; JNCC, 2021, RSPB, 2010; Collop *et al*., 2016; Davidson and Rothwell, 1993).

9.8.252 In summary, the probability of noise and visual disturbance stimuli occurring during construction is likely to be high. As described above, frequent disturbance at a level which could cause dispersive responses and relatively localised displacement of coastal waterbirds is likely with respect to construction activity associated with the inner finger pier and approach jetty. Only temporary and very localised responses are, however, anticipated during the construction of the outer finger pier. Only limited responses are anticipated with regard to the capital dredging. The magnitude to change for all commonly occurring waterbirds in the area is, therefore, considered to be **medium** with respect to the inner finger pier/approach jetty, **small** for the outer finger pier works and **negligible** for the capital dredging. The

sensitivity of coastal waterbirds in the area is considered to range from **low** for less sensitive species to **moderate-high** depending on the species (Table 9.23 to this chapter). Importance is considered to be high for all species because of the protection afforded to coastal waterbirds. Therefore, the potential effects of temporary disturbance during construction in the absence of any mitigation has been assessed as**:**

- Capital dredge: **Negligible** (all species);
- Outer finger pier (including connecting pontoon infrastructure): **Minor** (low sensitivity species) to **moderate** (high sensitivity species); and
- Inner finger pier and approach jetty: **Minor** (low sensitivity species) **to moderate to major** (high sensitivity species).

Operational phase

9.8.253 This section contains an assessment of the potential impacts to marine ecology receptors as a result of the operational phase of the IERRT project – those effects being reviewed in Table 9.25. This section includes an explanation of the rationale that was adopted for scoping in or out individual pathways for further assessment.

9.8.254 In this respect, it should be noted that only a high-level impact assessment has been provided with respect to maintenance dredging as this activity already falls within the consent granted by the current marine licence for the disposal of maintenance dredge material from the Port of Immingham (L/2014/00429/2). The level of maintenance dredging and disposal required at IERRT during the operational phase is anticipated to be required around three to four times a year (though this will be dependent on a range of factors - see Chapter 3 of the ES). The frequency and volume of material deposited at the disposal site from each load will not change compared with current maintenance dredging activities as the same plant and methods are proposed to be used. Furthermore, the volume of material that will need to be maintenance dredged from the IERRT berth pocket will be lower than the volumes of capital dredge material. Overall, the changes brought about as a result of the maintenance dredge and disposal of maintenance dredge material during operation will be comparable to that which already arises from the ongoing maintenance of the existing Immingham berths. Therefore, it is considered that the likely impacts on marine receptors as a result of maintenance dredging will be comparable to the existing maintenance dredge regime. The magnitude of potential impacts are also considered to be either equivalent to or lower than the capital dredge. On this basis, potential effects associated with all the maintenance dredging pathways that have been assessed as **insignificant** are discussed in Table 9.25 but have been scoped out of a more detailed assessment.

Table 9.25. Potential effects during operation scoped in / out of the further detailed assessment undertaken

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
Benthic habitats and species	Direct changes to benthic habitats and species beneath marine infrastructure due to shading	Operation	Yes	Changes in sunlight levels as a result of shading due to marine infrastructure has the potential to cause changes to the benthic community occurring in an area. This impact pathway has, therefore, been scoped into the assessment.
	Changes to intertidal habitats and species as a result of the movement of Ro-Ro vessels during operation	Berth operations	Yes	There is potential for physical disturbance and erosion to the foreshore nearby to the proposed development as a result of the movement of Ro-Ro vessels and other ships using the berths. This impact pathway has, therefore, been scoped into the assessment.
	Changes to benthic habitats and species as result of seabed removal during dredging	Maintenance dredging	Yes	Maintenance dredging causes the direct physical removal of marine sediments from the dredge footprint, resulting in the modification of existing marine habitats. The impacts to benthic fauna associated with the dredged material include changes to abundance and distribution through damage, mortality or relocation to a disposal site. Given that the dredge footprint has not previously been subject to any maintenance dredging, this impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	N/A	This pathway relates to changes in habitat resulting directly from seabed removal and is, therefore, not considered relevant to the

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
				dredge disposal activity. Potential effects resulting from sediment deposition at the disposal site are discussed below.
	Changes to habitats and species as a result of sediment deposition	Maintenance dredging and disposal	No	Maintenance dredge and dredge disposal will result in the deposition of sediments which has the potential to cause physical disturbance and smothering of seabed habitats. As a result of a less intensive dredge programme (and an overall lower predicted dredge volume), future maintenance dredging will result in smaller changes in SSC and sedimentation (within the dredge plumes and at the disposal site) as compared to the capital dredge. Deposition of sediment as a result of dredging will be highly localised and similar to background variability. The benthic species occurring within and near to the dredge area typically consist of burrowing infauna (such as polychaetes, oligochaetes or bivalves), which are considered tolerant to some sediment deposition. The predicted millimetric changes in deposition are, therefore, considered unlikely to cause smothering effects. In addition, the species recorded in the benthic invertebrate surveys are fast growing and/or have rapid reproductive rates which allow populations to typically rapidly recolonise disturbed habitats, many within a few months

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
				following the disturbance events (Ashley and Budd, 2020; De-Bastos and Hiscock, 2016; Tillin, 2016; Ashley, 2016). Clay Huts licensed disposal site (HU060) will be used for maintenance disposal as per the existing maintenance dredge licence. The disposal site is located in the mid channel and are subject to regular natural physical disturbance (and associated scouring) as a result of very strong tidal flows. This disposal site is already used for the disposal of maintenance dredge arisings (millions of wet tonnes of dredge sediment are disposed of at HU060 annually) which will also cause some disturbance due to sediment deposition. This is reflected in a generally impoverished assemblage at the disposal site. The benthic species recorded include mobile infauna (such as errant polychaetes e.g., *Arenicola* spp. and amphipods) which are able to burrow through sediment. They are, therefore, considered tolerant to some sediment deposition. In addition, characterising species typically have opportunistic life history strategies, with short life histories (typically two years or less), rapid

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
				maturation and the production of large numbers of small propagules which makes them capable of rapid recoverability should mortality as a result of smothering occur (Ashley and Budd, 2020; De-Bastos and Hiscock, 2016; Tillin, 2016; Ashley, 2016; Tyler-Walters and Garrard, 2019). On this basis, any effects are considered to be temporary and short term. Potential effects associated with this impact pathway has therefore been assessed as **insignificant** and has been scoped out of more detailed assessment.
	Indirect changes to seabed habitats and species as a result of changes to hydrodynamic and sedimentary processes	Maintenance dredging and disposal	No	The predicted physical processes impacts from future maintenance dredging will be similar to that which already arises from the ongoing maintenance of the existing Immingham berths. Maintenance dredging has the potential to result in changes to hydrodynamic and sedimentary processes (e.g., water levels, flow rates, changes to tidal prism, accretion and erosion patterns). However, as described in more detail in the Physical Processes assessment (Chapter 7 of this ES), only changes in hydrodynamic and sedimentary processes that are of a negligible magnitude

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
				are predicted. These changes will not be discernible against natural processes at nearby intertidal habitats. Furthermore, the predicted changes are not expected to modify existing subtidal habitat types found in the area. Potential effects associated with this impact pathway has therefore been assessed as **insignificant** and has been scoped out of more detailed assessment.
	Changes in water and sediment quality	Maintenance dredge and dredge disposal	No	Changes in water quality (as summarised in Chapter 8 of this ES) are also expected to be lower than for the capital dredge and similar to existing maintenance dredging. Elevated SSCs due to maintenance dredging and dredge disposal are considered to be of a magnitude that can occur naturally or as a result of existing maintenance dredging/disposal and sediment plumes resulting from dredging are also considered to dissipate relatively rapidly and be immeasurable against background levels within a relatively short duration of time (less than a single tidal cycle). Naturally very high SSCs typically occur year-round in the Humber Estuary, particularly during the winter months when storm events

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
				disturb the seabed and on spring tides. The estuarine benthic communities recorded in the region are considered tolerant to this highly turbid environment (De-Bastos and Hiscock, 2016; Tillin, 2016; Ashley, 2016). Magnitude of change is therefore assessed as negligible. The results of the sediment contamination sampling are summarised above and the Water and Sediment Quality chapter (Chapter 8 of the ES). In summary, low levels of contamination were found in the samples and there is no reason to believe the sediment will be unsuitable for disposal in the marine environment. During maintenance dredging and dredge disposal, sediment will be rapidly dispersed in the water column. Therefore, the already low levels of contaminants in the dredged sediments will be dispersed further. The probability of changes in water quality occurring at the disposal site is considered to be low and the overall exposure to change is considered to be negligible. The sensitivity of subtidal habitats and species to contaminants is assessed as low to moderate because, although contaminants can cause toxicity in subtidal communities, the concentrations of

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
				contaminants required to produce both lethal and sub-lethal effects are generally high (although responses vary considerably between species). Potential effects associated with this impact pathway has therefore been assessed as **insignificant** and has been scoped out of more detailed assessment.
	Underwater noise	Vessel operations, maintenance dredge and dredge disposal	No	Based on the information about underwater noise on invertebrates provided in the 'scientific context' review on underwater noise provided for the construction phase (paragraph 9.8.95 to 9.8.98), population level and mortality effects in benthic invertebrates are considered unlikely for piling or blasting. Maintenance dredging is known to produce lower noise levels than piling or blasting, and, therefore, there is unlikely to be significant effects on benthic invertebrates. Potential effects associated with this impact pathway has therefore been assessed as **insignificant** and has been scoped out of more detailed assessment.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
	Non-native species transfer during vessel operations	Vessel operations	Yes	Non-native species have the potential to be transported into the local area on the hulls of vessels during operation. Non-native invasive species also have the potential to be transported via vessel ballast water. This impact pathway has, therefore, been scoped into the assessment.
Fish	Changes to fish populations and habitat	Maintenance dredge and dredge disposal	No	As summarised above, the predicted impacts on benthic prey and fish receptors as a result of maintenance dredging are considered to be equivalent to or lower than the capital dredge and comparable to the existing maintenance dredge regime. The maintenance dredge footprint and proposed disposal site are considered unlikely to provide important nursery or spawning functions for fish species as a result of the disturbed nature of these habitats despite known nursery or spawning areas occurring in the wider Humber Estuary area[36]. Therefore, while during dredging, there is the potential for fish along with roe (eggs) of these species to be removed, sub-optimal spawning conditions are likely to be present with more optimal habitat occurring in the wider Humber Estuary

[36] The maintenance dredge footprint and nearby area is already subject to regular natural seabed disturbance as a result of existing vessel movements and ongoing maintenance dredging. The disposal ground is located in a highly dynamic area with the mobile sandbanks subject to regular natural physical disturbance (and associated scouring) as a result of very strong tidal flows and deposition due to regular maintenance dredge activity.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
				area. In addition, the dredge footprint is considered negligible in the context of suitable spawning habitat in the region. As summarised above, the predicted impacts on benthic habitats and species (and therefore prey for fish receptors) as a result of maintenance dredging are considered to be equivalent or lower than the capital dredge and comparable to the existing maintenance dredge regime. Most fish species are opportunistic and generalist feeders, which means that they are generally not reliant on a single prey item. Fish are also mobile species and will easily be able to move away from the zone of influence and utilise other nearby areas for foraging. Furthermore, the area of habitat change will only represent a small proportion of the foraging ranges of many fish species (particularly the larger and more commercial species such as whiting, plaice and Dover sole). Potential effects associated with these impact pathways are, therefore, assessed as **insignificant** and have been scoped out of more detailed assessment.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
	Changes in water and sediment quality	Maintenance dredge and dredge disposal	No	Changes in water quality (as summarised in Chapter 8 of this ES) are also expected to be lower than for the capital dredge and similar to existing maintenance dredging. Fish within the Humber estuary are considered well adapted to living in an area with variable and typically high suspended sediment loads. Fish feed on a range of food items and, therefore, their sensitivity to a temporary change in the availability of a particular food resource is considered to be low. Their high mobility enables them to move freely to avoid areas of adverse conditions and to use other food sources in the local area. With specific respect to migratory fish, as mentioned in paragraph 9.8.134, salmonids and other migratory fish can be sensitive to elevated suspended sediment concentrations. However, these species are known to migrate through estuaries with high suspended sediment concentrations (including the Humber Estuary). Elevated SSCs due to dredging are considered to be of a magnitude that can occur naturally or as a result of ongoing maintenance dredging/disposal.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
				Sediment plumes resulting from dredging and dredge disposal are also considered to dissipate relatively rapidly and be immeasurable against background levels within a relatively short duration of time (less than a single tidal cycle) as described in more detail in the Physical Processes assessment (Chapter 7 of this ES). Therefore, salmonids and other migratory fish would also be able to avoid the temporary sediment plumes. Based on these factors there is therefore considered limited potential for migrating fish to be adversely affected by the predicted changes in SSC. Given that elevated SSCs due to dredge and dredge disposal are considered to be in the range of variability that can occur naturally in the Humber Estuary (which has very high SSCs year-round, particularly during the winter months) as well as due to existing ongoing maintenance dredging/disposal and that plumes will be temporary in nature, sensitive life stages of fish occurring in the region such as larvae and juvenile fish are considered unlikely to be adversely effected by the dredging.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
				With respect to sediment contamination, generally low levels of contamination were found in the sediment contamination samples as presented in the Water and Sediment Quality assessment in Chapter 8 of this ES. Based on this sampling data, the overall level of contamination in the proposed dredge area is considered to be low and the sediment plume would be expected to rapidly dissipate by the strong tidal currents in the area. Significant elevations in the concentrations of contaminants within the water column are not anticipated. Potential effects associated with this impact pathway has therefore been assessed as **insignificant** and has been scoped out of more detailed assessment.
	Underwater noise	Maintenance dredge and dredge disposal	No	The outcomes of the assessment of underwater noise disturbance from capital dredging activities during construction will be the same for maintenance dredging activities during operation. A worst case source level for all types of dredgers has been applied to the underwater noise assessment and, therefore, the predicted ranges of effect are applicable to both the maintenance and capital dredging

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
				activities. Underwater noise effects on fish were assessed as insignificant during capital dredging. The magnitude of potential impact is considered equivalent during maintenance dredging. The potential effect is, therefore, considered to be **insignificant** and has been scoped out of more detailed assessment.
	Underwater noise	Vessel operations	No	During the operational phase there is the potential for noise disturbance to fish species as a result of vessel movements. The worst case source level associated with vessels during operation is the same as for dredging activity and, therefore, the predicted ranges of effect applicable to vessel and dredging operations are the same. Overall, only mild behavioural responses in close proximity to the Ro-Ro vessels are anticipated with noise levels unlikely to be discernible above ambient levels in the wider Humber Estuary area. The potential effect is, therefore, considered to be **insignificant** and has been scoped out of more detailed assessment.
	Lighting	Vessel operations	No	The marine infrastructure will be lit for safety and operational purposes. For any shoaling fish near the surface, the proposed development will potentially only cause minor changes in behaviour such as increased shoaling in the vicinity of the light source. Such responses could increase the risk of predation

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
				but could also have positive effects such as enhancing feeding efficiency. The low levels of lighting would not cause disruption or blocking of migratory routes. The potential effect is, therefore, considered to be **insignificant** and has been scoped out of more detailed assessment.
Marine mammals	Underwater noise	Maintenance dredge and dredge disposal	No	The outcomes of the assessment of underwater noise disturbance from capital dredging activities during construction will be the same for maintenance dredging activities during operation. A worst case source level for all types of dredgers has been applied to the underwater noise assessment and, therefore, the predicted ranges of effect are applicable to both the maintenance and capital dredging activities. Underwater noise effects on marine mammals were assessed as insignificant during capital dredging with only short-term and mild behavioural response predicted. The magnitude of potential impact is considered equivalent during maintenance dredging. The potential effect is, therefore, considered to be **insignificant** and has been scoped out of more detailed assessment.
	Underwater noise	Vessel operations	No	During the operational phase there is the potential for noise disturbance to marine mammal species as a result of vessel movements. The worst case source level

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
				associated with vessels during operation is the same as for dredging activity and, therefore, the predicted ranges of effect applicable to vessel and dredging operations are the same. Overall, only mild behavioural responses in close proximity to the Ro-Ro vessels are anticipated with noise levels unlikely to be discernible above ambient levels in the wider Humber Estuary area. The potential effect is, therefore, considered to be **insignificant** and has been scoped out of more detailed assessment.
	Visual disturbance of hauled out seals	Vessel operations, maintenance dredge and dredge disposal	No	The nearest established breeding colony for grey seals is located over 25 km away at Donna Nook. Approximately 10 to 15 grey seals were also observed hauling out on mudflat at Sunk Island (on the north bank of the Humber Estuary) during the project specific benthic surveys as detailed in Appendix 9.1 to this ES. This haul out site is located approximately 4 km north east from the proposed development. No seal haul out sites are known to occur nearer to the proposed development. Seals which are hauled out on land, either resting or breeding, are considered particularly sensitive to visual disturbance (Hoover-Miller *et al*, 2013).

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
				The level of response of seals is dependent on a range of factors, such as the species at risk, age, weather conditions and the degree of habituation to the disturbance source. Hauled out seals have been recorded becoming alert to powered craft at distances of up to 800 m although seals generally only disperse into the water at distances <150-200 m (Wilson, 2014; Mathews, *et al*., 2016; Henry and Hammill, 2001; Strong and Morris, 2010). For example, in a study focusing on a colony of grey seals on the South Devon coast, vessels approaching at distances between 5 m and 25 m resulted in over 64% of seals entering the water, but at distances of between 50 m and 100 m only 1% entered the water (Curtin *et al*., 2009). Recent disturbance research has also found no large-scale redistribution of seals after disturbance with most seals returning to the same haul out site within a tidal cycle (Paterson *et al.,* 2019). Based on this evidence, seals hauled out on the intertidal habitats of Sunk Island (located on the opposite bank to the proposed development) are out of the zone of influence of any potential visual disturbance effects as a result of maintenance dredging and vessel

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
				operations. The potential for disturbance to hauled out seals has, therefore, been scoped out of the assessment.
	Collision risk	Vessel operations	No	Vessels using the berths during operation will be typically approaching at slow speeds (2-4 knots) and maintenance dredging/dredge disposal will be mainly stationary or travelling at low speeds (2-6 knots), making the risk of collision very low. Although all types of vessels may collide with marine mammals, vessels traveling at speeds over 10 knots are considered to have a much higher probability of causing lethal injury (Schoeman *et al.,* 2020). Furthermore, the region is already characterised by heavy shipping traffic. The additional operational vessel movements resulting from the proposed development will only constitute a small increase in vessel traffic in the area on a typical day (up to six additional Ro-Ro vessel movements per day at the Port of Immingham, as well as tugs) which represents approximately a 3% increase in vessel traffic in the study area. There will also be maintenance dredger and barge movements but that is estimated to only be necessary approximately three to four times a year.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in more detailed assessment?	Justification
				In general, incidents of mortality or injury of marine mammals caused by vessels remain a relatively rare occurrence in UK waters (ABP Research 1999; CSIP, 2020). For example, out of 144 post mortem examinations carried out on cetaceans in 2018, only two (1.4%) were attributed to boat collision with the biggest causes of mortality including starvation and by-catch, although some incidents are likely to remain unreported (CSIP, 2020). In addition, marine mammals frequently foraging within the region will routinely need to avoid collision with vessels and are, therefore, considered adapted to living in an environment with high levels of vessel activity. This impact pathway has, therefore, been scoped out of the assessment.
Coastal waterbirds	Direct changes to foraging and roosting habitat as a result of marine infrastructure	Berth operations	Yes	Marine infrastructure associated with the proposed development (raised jetty structure, linkspan etc.) could potentially cause direct damage or reduced functionality to waterbird feeding and roosting habitat. This impact pathway has, therefore, been scoped into the assessment.
	Noise and visual disturbance	Berth operations	Yes	During operation, there is the potential for airborne noise and visual disturbance to affect coastal waterbirds. This impact pathway has, therefore, been scoped into the assessment.

Benthic habitats and species

9.8.255 This section contains an assessment of the potential impacts to benthic ecology receptors as a result of the operational phase of the IERRT project. The following impact pathways have been assessed:

- Changes to benthic habitats and species as result of seabed removal during maintenance dredging (paragraphs 9.8.256 to 9.8.261);
- Direct changes to benthic habitats and species beneath marine infrastructure due to shading (paragraphs 9.8.262 to 9.8.268);
- Non-native species transfer during vessel operations (paragraphs 9.8.269 to 9.8.271); and
- Changes to intertidal habitats and species as a result of the movement of Ro-Ro vessels during operation (paragraphs 9.8.272 to 9.8.279).

Changes to benthic habitats and species as result of seabed removal during maintenance dredging

General scientific context

9.8.256 Scientific evidence on this potential impact pathway has already been provided above in the construction (capital dredge) sub-section of the impact assessment and is, therefore, not repeated here.

Project impact assessment

9.8.257 Maintenance dredging causes the direct physical removal of marine sediments from the dredge footprint, resulting in the modification of existing marine habitats. The impacts to benthic fauna associated with the dredged material include changes to abundance and distribution through damage, mortality or relocation to a disposal site.

9.8.258 As summarised in the Physical Processes assessment (Chapter 7 of this ES), the level of maintenance dredging and disposal required at IERRT during the operational phase is anticipated to be required around three to four times a year (though this will be dependent on a range of factors - see Chapter 3 of the ES). Volumes of material from maintenance dredging (up to 120,000 m³ annually, to be dredged as required) of the IERRT berth pocket will be lower than those from the original capital dredge (190,000 m³).

9.8.259 Maintenance dredging will create similar seabed sedimentary conditions to that occurring following capital dredging due to sediment accretion. Accretion will return the surface layer of the seabed in the dredge footprint to its existing sediment character (i.e., fine sediment with a high silt content) which would then be expected to start to recolonise relatively rapidly by a similar assemblage to baseline conditions[37]. However, maintenance

[37] The project-specific subtidal survey (Section 9.6 and Appendix 9.1 of the ES) recorded a benthic community characterised by nematodes, the mudshrimp *Corophium volutator,* polychaetes (such as *Streblospio shrubsolii Polydora cornuta Tharyx spp and Nephtys spp.*), oligochaetes *Tubificoides spp.* and barnacle *Amphibalanus improvises*. These characterising

dredging of the berth pockets is expected to cause an ongoing source of seabed disturbance, albeit in these localised areas. It should be noted that no dredging will be required around the jetty structures. Furthermore, the project-specific subtidal survey (Section 9.6 of this chapter and Appendix 9.1 to this ES) recorded a generally impoverished benthic community which is likely to reflect the existing high levels of physical disturbance in the area due to strong near bed tidal currents and sediment transport.

9.8.260 All the species recorded are considered commonly occurring and not protected with the faunal assemblage recorded considered characteristic of subtidal habitats found more widely in this section of the Humber Estuary (ABPmer, 2009; IECS, 2010; Able UK Limited, 2021). Subtidal habitats in the area around the Port of Immingham are also considered to be typically of limited ecological value.

9.8.261 Based on the evidence provided above and applying the project impact assessment methodology, the magnitude of the change to the subtidal habitats and associated benthic species is considered to be small and although the probability of occurrence is high, the overall exposure is assessed as low. The sensitivity of subtidal habitats to seabed disturbance within the dredge footprint is considered to be low given the high recoverability rates. Vulnerability is, therefore, assessed as low. While subtidal benthic communities are considered commonly occurring in the region, subtidal habitats form a component of the 'Estuaries' feature of the SAC. Importance is, therefore, considered to be moderate. Overall, the potential effect is assessed as **insignificant to minor**.

Direct changes to benthic habitats and species beneath marine infrastructure due to shading

General scientific context

9.8.262 Artificial shading such as due to pontoons or jetty/pier decking has the potential to cause localised changes to the structure and functioning of biological communities in natural ecosystems (Van Colen *et al*., 2015; Pardal-Souza *et al*., 2017; Tolhurst *et al*., 2020).

9.8.263 In sedimentary habitats microphytobenthos, macrofauna, sediment erodibility and biogeochemical sediment properties are often found to differ significantly between shaded and unshaded sediments (Defew *et al*., 2004; Thrush *et al*., 2014; Tolhurst *et al*., 2020). Microphytobenthos are significant drivers of ecosystem functioning in benthic habitats influencing biogeochemical properties of sediment, food web dynamics (Byers and Grabowski, 2014) and sediment erodibility (Grabowksi *et al*., 2011)). Heavy shading alters microphytobenthos assemblages causing a variety of responses, including changes in biomass, pigment ratios, species richness and diversity (Defew *et al*., 2004; Tolhurst *et al*., 2020). These changes can

species dominated the assemblage and contributed almost entirely to the total abundances of organisms recorded at most of the sample stations. These species are typically fast growing and/or have rapid reproductive rates which allow populations to fully re-establish in typically less than 1-2 years and for some species within a few months (De-Bastos and Hill, 2016; De-Bastos and Hiscock, 2016; Tillin, 2016; Ashley, 2016).

therefore have cascading effects on the sediments they inhabit and associated faunal assemblages (Thrush *et al*., 2014; Van Colen *et al*., 2015; Tolhurst *et al*., 2020). For example, Tolhurst *et al*. (2020) found heavy shading of an intertidal mudflat caused directional responses in sediment properties, in line with a decrease in microphytobenthos, including reductions in chlorophyll *a*, colloidal carbohydrate, erosion threshold and total carbohydrate; and increased erosion rate and water retention. This resulted in significant changes in the faunal assemblage, driven by large decreases in oligochaetes and sabellid polychaetes – likely to be a direct response to the reduction of food; either the amount of microphytobenthos, or perhaps bacteria, or meiofauna (Tolhurst *et al*., 2020).

9.8.264 Shading of hard substrates, such as rocky shores and seawalls, can often alleviate stressful conditions associated with temperature and desiccation, caused by emersion during low tide (Blockley, 2007). However, this can also cause shifts in the structure and diversity of biological communities, by reducing macroalgae cover (Blockley and Chapman, 2006; Blockley 2007), increasing the abundance of filter feeding invertebrates and mobile consumers (Takada, 1999; Blockley, 2007), altering sessile assemblages (Williams, 1994) and influencing larval recruitment (Blockley and Chapman, 2006; Pardal-Souza *et al*., 2017). For example, Pardal-Souza *et al*. (2017) found shading to consistently affect the biological community of rocky shores, such that the biomass and cover of macroalgae, and the size of most sedentary grazers, were smaller. Additionally, in the infralittoral fringe there was a shift in dominance from macroalgae to invertebrate filter feeders (Pardal-Souza *et al*., 2017). Larval recruitment was also affected, with oysters and barnacles recruiting more in shaded habitats (Pardal-Souza *et al*., 2017).

Project impact assessment

9.8.265 Changes in sunlight levels as a result of shading have the potential to cause changes to the benthic community occurring in an area. In particular, shading can reduce the amount of light available for species that perform photosynthesis such as macroalgae species (seaweeds), macrophytes (such as saltmarsh plants) and microphytobenthos.

9.8.266 The floating pontoons are inevitably likely to cause some shading of subtidal habitats. The project-specific benthic data suggests that a relatively impoverished invertebrate community, consisting predominantly of estuarine oligochaete worms, polychaetes and mobile crustaceans such as amphipods is present in the area. These characterising species live on the seabed or infaunally (in the sediment) and are not directly reliant on light levels to feed (e.g., species are suspension feeders, deposit feeders and predators). However, there may be changes in microphytobenthos abundance on the sediment surface and within the sediment as a result of shading. This could alter food supply and sediment cohesion to deposit feeding species. On this basis, some changes to the benthic community may be observed in terms of a reduction in productivity but the broad faunal assemblage is likely to persist. Furthermore, the highly turbid conditions in

the Humber Estuary generally limits the amount of sunlight reaching the seabed in any case and the area impacted will also be highly localised.

9.8.267 The open piled approach jetty and linkspan could cause some shading to intertidal mudflat habitat. Given that these structures will be located several metres above the seabed, however, some natural light would be expected to reach the mudflat from either side of these structures at different times of day. Shading at the level predicted would only be expected to cause negligible changes to the growth rates of macroalgae species (seaweeds) and microphytobenthos occurring on the foreshore. Furthermore, no saltmarsh and only limited macroalgae occurs on mudflats in this area.

9.8.268 Based on the above, the magnitude of the change will be negligible. Whilst the probability of some shading is inevitably likely to be high, the overall exposure will be negligible. The sensitivity of benthic habitats and species found in the footprint to the scale of shading effects is considered to be low and thus vulnerability is considered to be none. While both the subtidal and intertidal benthic communities are commonly occurring in the region, intertidal habitats are protected and of functional importance for waterbirds. Importance is therefore considered to range from moderate (for subtidal habitats) to high (for intertidal habitats). Consequently, the overall impact is assessed as **insignificant.**

Non-native species transfer during vessel operations

General scientific context

9.8.269 Scientific evidence on this potential impact pathway has already been provided above in the construction sub-section of the impact assessment and is, therefore, not repeated here (paragraphs 9.8.103 to 9.8.107).

Project impact assessment

9.8.270 Non-native species have the potential to be transported into the study area on ships' hulls during maintenance dredging and through operational vessels. Non-native invasive species also have the potential to be transported via ship ballast water. Seawater may be drawn into tanks when the ship is not carrying cargo, for stability, and expelled when it is no longer required. This provides a vector whereby organisms may be transported long distances.

9.8.271 In view of current legislation (described in more detail in the assessment of non-native species during construction, paragraphs 9.8.106 to 9.8.107) and the fact that potential biosecurity risks are managed through ABP's existing biosecurity management procedures, the probability of the introduction and spread of non-native species from operational phase is considered to be low. However, given that the magnitude of change is unknown, magnitude ranges from negligible to large depending upon the scale and nature of any non-native species introduction, thus the exposure ranges from negligible to low at worst. The sensitivity of all intertidal and subtidal receptors to non-native species introductions is expected to range from low to moderate. Vulnerability is, therefore, considered to be low. In addition, importance is considered to range from high (for intertidal mudflats) to moderate (for

subtidal habitats). The overall impact is, therefore, assessed, as **insignificant to minor adverse**.

Changes to intertidal habitats and species as a result of the movement of Ro-Ro vessels during operation

General scientific context

9.8.272 Intertidal mudflats are subjected to successive periods of erosion and sedimentation which are controlled by sediment supply and hydrodynamic factors such as tides, fluvial discharge and wind (Dyer, 1994; O'Brien *et al*., 2000). This erosion and sedimentation can often be intensified by boat traffic (Verney *et al*., 2007).

9.8.273 A vessel travelling through water generates a combination of both short period waves (referred to as a wake, which propagate from the bow and stern sections of the vessel) and long-period waves, which result in surface 'drawdown.' The net effect of these waves, along with propeller-induced turbulence, is referred to as 'shipwash.' Studies have shown shipwash to generate large bottom shear stress values, enhancing the erosion of mudflats (Parchure *et al*., 2001; Verney *et al*., 2007). The severity of these erosion processes is dependent on several factors, including the speed of the vessel, the size of the vessel and the distance between the vessel and ecological features, since the energy in waves is a function of speed and displacement (UK Marine SACs Project, 2001).

9.8.274 Large, fast moving vessels can cause, what are referred to as, high energy events (HEEs), which can result in major erosion processes (erosion of more than 5 mm thickness) (Soulsby *et al*., 1993; Grant and Madsen, 1979; Verney *et al*., 2007). These events increase bottom shear which can result in bed elevation, changes in the sediment type of the seabed and, in severe cases, the loss of habitats and marine benthic communities (Parchure *et al*., 2001; Deloffre *et al*., 2005; Verney *et al*., 2007; Cundy *et al*., 2005). HEEs are observed most frequently under specific conditions such as low water height and amplitude waves (Verney *et al*., 2007). Low-amplitude erosion processes are often observed at very shallow water depths at the beginning of a flood tide and at the end of the ebb tide (Verney *et al*., 2007). The amplitudes and severity of these HEEs demonstrate the importance vessel traffic plays in mudflat dynamics and sediment fluxes.

9.8.275 Additionally, for vessels moving at finite depth in confined channels, depression wakes, or Bernoulli wakes, can become more important at influencing mudflat erosion than other perturbations (Soomere, 2006; Aage *et al*., 2003; Parnell *et al*., 2015). These wakes are often generated by displacement type vessels, such as trawlers and large sailing vessels, and their amplitude increases with an increase in the blocking coefficient (the ratio of the product of the ship width and draught to the cross-sectional area of the channel) and ship velocity. Depression wakes can impact mudflats through morphological changes (Erirf and Soomere 2004; Zaggia *et al*., 2017).

Project impact assessment

9.8.276 There is potential for physical disturbance and erosion to the foreshore nearby to the proposed development as a result of the movement of Ro-Ro vessels and other ships using the berths.

9.8.277 Foreshore erosion can cause a change in elevation and the sediment type of the seabed (e.g., if erosion removes accreted mudflat sediment and exposes coarser sediment) or result in the loss of a habitat in more severe cases (e.g., if the foreshore is completely eroded below a sea wall or other coastal defence).

9.8.278 Vessels approaching the floating pontoons will be approaching at slow speeds in order to allow berthing. This will keep any shipwash to a minimum. In addition, this section of the Humber Estuary is already subject to high vessel traffic levels with vessels regularly berthing at jetties close to intertidal areas with no known significant erosional effects recorded.

9.8.279 On this basis, magnitude of impact and consequently exposure is considered to be negligible. As a consequence, whilst the sensitivity of species to habitat loss and change is considered to be medium to high and the importance of intertidal habitats high, the potential effect is considered to be **insignificant**.

Coastal waterbirds

9.8.280 This section contains an assessment of the potential impacts to coastal waterbird receptors as a result of the operational phase of the IERRT project. The following impact pathways have been assessed:

- Direct changes to foraging and roosting habitat as a result of the presence of the infrastructure (paragraphs 9.8.281 to 9.8.288); and
- Disturbance of waterbirds during operation (paragraphs 9.8.289 to 9.8.300).

Direct changes to foraging and roosting habitat as a result of the presence of infrastructure

9.8.281 For clarity it should be noted this pathway relates to potential changes to foraging and roosting habitat as a result of the physical presence of marine infrastructure. The direct loss of intertidal mudflat habitat due to the presence of the infrastructure (i.e., the piles) was assessed in the construction phase) (paragraphs 9.8.13 to 9.8.21).

9.8.282 It should also be noted that this pathway specifically relates to the structures themselves rather than human activity on the infrastructure which is assessed in the disturbance pathway below. However, it is acknowledged that such effects are likely to some extent to be interrelated.

General scientific context

9.8.283 Any port and harbour development has the potential to cause reduced functionality to waterbird feeding and roosting habitat due to port infrastructure.

9.8.284 Waterbirds often show a preference for foraging in open spaces with clear sightlines when feeding so that scanning distances can be maximised. On this basis, certain species of coastal waterbirds might show a reluctance to approach tall anthropogenic structures or those that create enclosed spaces. One of the main reasons for not approaching a structure is thought to be the same as waders avoiding feeding near high banks, tall hedges/trees and in enclosed spaces (such as small fields surrounded by trees) (Milsom *et al*., 1998), i.e., they are trying to avoid any sudden attack by a predator that may be hiding in or behind the structure. Just as raptors often exploit tall structures to aid prey detection, species that may be targeted by raptors would naturally avoid tall structures to minimise predation risk. Many waders and waterfowl may avoid areas in which their sightlines are reduced, even though in certain circumstances this may reduce the quantity of high-quality foraging habitat available to them or access to important roosting sites. However, it is often difficult to separate the direct impact of the structure from other factors associated with development, such as human activity causing potential disturbance stimuli (assessed below in paragraphs 9.8.289 to 9.8.300) (Walters *et al*., 2014).

9.8.285 The addition of anthropogenic structures to coastal waters can also result in a new habitat for colonising epibiota (such as mussels, periwinkles, limpets and barnacles) which are considered prey items for certain wading birds such as Turnstone, Oystercatcher and Purple Sandpiper. Certain species (such as Turnstone) are also regularly recorded feeding on epifaunal species which have colonised anthropogenic structures in the intertidal such as jetties and coastal defences (Naylor *et al*., 2017). Coastal waterbirds also regularly roost on a variety of artificial structures in harbours and ports including pontoons, platforms, sea walls and dolphins (mooring structures) (Jackson *et al.,* 2021; Jackson, 2017; Cutts, 2021). Species commonly recorded in the UK using such structures include gulls, Cormorants and waders such as Dunlin, Turnstone and Oystercatchers. Factors that can influence the level of use by waterbirds of artificial roosting structures include the proximity to nearby feeding grounds, the level of human disturbance and perceived predator risk.

Project impact assessment

9.8.286 Marine infrastructure associated with the proposed development (raised jetty structure, linkspan etc.) will not prevent any direct access to established roosting habitat used by coastal waterbirds in the area. This includes the outfall pipe which is used by roosting Cormorants and gulls and the derelict concrete structures present on the mudflat used by Turnstone and gulls. In addition, shading caused by the structures would not be expected to cause significant changes to benthic prey resources used by coastal waterbirds as assessed above (paragraphs 9.8.262 to 9.8.268).

9.8.287 The approach jetty will be an open piled structure with large gaps between each of the piles (approximately 12 m) and between the jetty deck and the foreshore seabed (i.e., the mudflat surface) (3 m to 8 m). This will minimise the enclosed feel and allow birds feeding near the structure to maintain sightlines. It should be noted that observations from the ornithology surveys in the area suggest that birds regularly feed in very close proximity to both the Eastern Jetty (approximately 250 m from the proposed development) and the Immingham Oil Terminal approach jetty (approximately 50 m from the proposed development) – which are both similar open piled structures - with species such as Redshank, Dunlin, Turnstone regularly recorded underneath jetties and Curlew, Shelduck and Black-tailed Godwit approaching them relatively closely. On this basis, birds would be expected to show similar highly localised responses to structures associated with the proposed development with responses ranging from no avoidance for some species to potentially some local avoidance (i.e., directly underneath or in close proximity) for other species. This is unlikely, however, to change the overall distribution of waterbirds more widely along the foreshore fronting Immingham.

9.8.288 Based on the above, birds would be expected to feed below or very close to the proposed development's approach jetty and indeed other infrastructure on the foreshore – none of which will prevent direct access to established roosting habitat. As a consequence, any avoidance of marine infrastructure is expected to be limited (and highly localised) and is unlikely to change the overall distribution of waterbird assemblages more widely on the foreshore in the local area. On this basis, while the probability of some localised effects is likely to be high, the magnitude and consequent exposure to change will be low. The sensitivity of coastal waterbirds to direct changes to foraging and roosting habitat on the scale predicted is likely to be moderate and thus vulnerability will be low. Importance is high because of the protection afforded to coastal waterbirds. Consequently, the overall impact is assessed as **minor**.

Disturbance of waterbirds during operation

General scientific context

9.8.289 Operational ports, wherever located, inevitably present as a potential source of disturbance in the coastal environment. Waterbird monitoring work in the vicinity of port locations has generally recorded limited evidence of birds on nearby intertidal habitat being disturbed through regular land side port operations with birds often becoming habituated (such as the movement of vehicles, cranes and cargo containers) (ABPmer; 2015; ABPmer, 2013). For example, Cutts (2021) reported that most species of waterbird assemblages utilising estuarine habitats adjacent to major infrastructure (such as power stations, jetties, bridges, port facilities etc) appear to be tolerant and will both roost and forage within less than 50 m of the working infrastructure. Waterbirds have also been recorded regularly feeding under large industrial jetties as well as roosting on jetties and harbour walls.

9.8.290 Disturbance events have also been recorded as part of the ongoing IOH monitoring in the Port of Immingham area since winter 2005/06[38]. This includes any potential disturbance due to operational activities on various jetties (such as the Immingham Oil Terminal (which includes vehicle activity), Western Jetty, Eastern Jetty and Immingham Bulk Terminal). During the surveys the vast majority of the disturbance observed was caused due to either raptors (such as peregrine and sparrowhawk), recreational activities (angling or dog walking) or maintenance work on the seawall. Disturbance was also recorded on several occasions as a result of construction or maintenance work on several of the jetties. No disturbance, however, was recorded as a result of vessel movements or operational activity at or near the berths or jetties.

9.8.291 In general, human presence on the foreshore (e.g., walking) is considered to cause greater disturbance than vehicles (McLeod *et al.,* 2013; Guay *et al.,* 2014; IECS, 2009a). With specific respect to activity associated with commercial operations and works, observations from monitoring and other studies (including specifically on the Humber Estuary), suggests that disturbance responses are typically greater for personnel in the open, compared to when enclosed within a vehicle at the same distances (Cutts *et al.,* 2021). Waterbirds are also considered more likely to habituate to vehicle movements which occur in a more predictable manner and in a spatially limited area compared to more erratic activity (such as quad bikes on the foreshore) (Burton *et al*., 2002b; Natural England, 2017; Cutts *et al.,* 2021).

9.8.292 Disturbance events from powered vessels have been recorded within 100 m of the receptor with vessels approaching at faster speeds eliciting higher disturbance. Predictability and randomness are factors of vessel traffic which can cause variation in waterbird response. Literature suggests that large commercial vessels consistently using defined routes (such as ferries or cargo ships) elicit less of a disturbance response than recreational craft which are more unpredictable in terms of speed and course and thus their disturbance potential for birds may be enhanced (Rodgers and Schwikert, 2002; Burger and Gochfield, 1998; Schwemmer *et al*., 2011; Glover *et al*., 2015).Monitoring of potential disturbance due to the movements of vessels berthing at pontoons associated with offshore windfarm Operation and Maintenance (O&M) facilities in several port locations near to mudflats used by waterbirds recorded evidence of some mild and localised disturbance and avoidance although events were generally infrequent with larger disturbance events (causing bird to fly out of the area) only occurring more rarely. Consistent evidence of changes (reductions) in waterbird abundance in the local area which could be linked to the operational activities was not recorded (ABPmer, 2015; ABPmer, 2021).

[38] These surveys have been undertaken twice a month from October to March (see Section 9.3 for further information on these surveys).

Project impact assessment

9.8.293 Operational disturbance stimuli could occur as a result of Ro-Ro vessel movements. The nearest berth during spring tide periods following completion of the capital dredge will be located approximately 40 to 150 m from intertidal mudflat used by coastal waterbirds.

9.8.294 Hundreds of commercial vessel movements take place each year close to the location of the proposed new berths. Commercial vessel activity is, therefore, a relatively constant feature along the Immingham port frontage close to the foreshore. In particular, vessels using the Eastern Jetty berth within close proximity (low tens of metres) to lower shore mudflats. These mudflats are used extensively by feeding waterbirds around the tideline. The Eastern Jetty is a busy liquid bulks berth which regularly receives large vessels. At its eastern termination a floating pontoon also provides berthing for some of the port's tugs. However, as described above in the scientific context section, no disturbance events linked to vessel movements either at the Eastern Jetty or any other berthing facility in the Port of Immingham area has been recorded during the IOH bird surveys.

9.8.295 Disturbance could also occur as a result of people (such as workers) or vehicles on berthing infrastructure (floating pontoons, finger piers, approach jetty, linkspan) near the intertidal. The proposed development will see some activity of workers/personnel on the finger piers during vessel mooring and disembarkation. Outside these periods, movements of pedestrians will be minimal with almost all access to the vessels using motorised vehicles (HGVs and Ro-Ro tractors/trailers).

9.8.296 On a daily basis there will typically be a steady flow of vehicle movements coming and going from the Ro-Ro vessels throughout the day. The vehicle movements will, however, be undertaken at slow speeds (typically <12 miles per hour) and also in a predictable and consistent manner (i.e., producing the same type of visual/noise stimuli each time). Based on the evidence reviewed above, these are all attributes which support habituation and therefore are likely to limit disturbance responses. It should also be noted that many of the existing approach jetties in the Port of Immingham have some vehicular access. The IOT approach jetty in particular has regular vehicle movements with no disturbance associated with this activity recorded during the IOH bird surveys (as described in the general scientific context above).

9.8.297 Regarding engineering and maintenance works, this activity is expected to be limited and only required occasionally.

9.8.298 The level of response that waterbirds will have to the three new berths when operational will be dependent to some extent on the sensitivity they have to anthropogenic disturbance stimuli. For example, species such as Turnstone and Dunlin are typically more tolerant than Shelduck, Curlew and godwits as summarised in Table 9.23. The evidence presented above, however, suggests that birds are typically less affected by defined regular movements of people or vehicles near the shoreline (as occurs in port environments)

than by random movements of people on the foreshore. Birds are regularly recorded feeding nearby or below port structures such as jetties or pontoons and appear to be relatively tolerant to normal day-to-day port operational activities.

9.8.299 It is acknowledged, however, that disturbance can occur as result of any human activity irrespective of habituation, if the activity occurs in sufficiently close proximity to a species so as to trigger a responsive reaction. Given that Ro-Ro vessels and human activity associated with operations will be occurring close to the foreshore (such as on the approach jetty), intermittent disturbance responses are, therefore, still possible. This may particularly be the case at first when birds are likely to be less habituated to the new activity or as a response to a more infrequent sporadic type of activity on a structure with which birds are less familiar (such as maintenance works which are likely to be highly infrequent). Responses for most species are expected typically to involve infrequent, mild behavioural responses in a localised area in the vicinity of the pontoon or approach jetty. The responses observed in birds are likely to range from increased vigilance to short flights with birds rapidly resettling and resuming feeding near their original location. More sensitive species could show localised avoidance and larger disturbance events (causing birds to flush and temporarily disperse from the vicinity of the proposed development). That said, rather than dispersing from the area completely, however, it is anticipated that the birds will temporarily redistribute within the local area to feed.

9.8.300 Based on the above, the probability of some disturbance occurring is considered to be high with some disturbance at a level which could cause dispersive responses and potentially short-term and localised displacement of coastal waterbirds. It is expected, however, that birds will become habituated relatively quickly which will limit any longer-term disturbance responses to a relatively localised area around berthing infrastructure. The magnitude and consequently exposure to change is, therefore, likely to be low. The sensitivity of coastal waterbirds in the area is considered to range from low to moderate depending on the species. This is because even species considered relatively sensitive to disturbance appear to show relatively limited responses to operational stimuli. Importance is high because of the protection afforded to coastal waterbirds. As a consequence, the impact of disturbance during operation has been assessed as **minor adverse**. It is acknowledged, however, that there is some uncertainty with respect to the extent and rate of habituation given the overlap of the berthing infrastructure with the foreshore. On this basis mitigation in the form of screening is proposed on a precautionary basis as discussed further in Section 9.9 of this chapter.

9.9 Mitigation measures

Primary mitigation

9.9.1 Primary mitigation measures are modifications to the location or design of the development made during the pre-application phase that are an inherent (or embedded) part of the project. These were captured and taken into account

as part of the project's impact assessment and scheme evolution and include, with a view to reducing the extent of intertidal and subtidal loss by:

- The reduction of the number of berths from four to three (with the berth closest the intertidal removed);
- The orientation of the berths away from the intertidal into deeper water; and
- The reduction of the dredge pocket intertidal extent (through using a 1 in 4 side slope).

Secondary mitigation

9.9.2 Secondary mitigation measures will alter the risk of exposure and, hence, will require significance to be re-assessed and thus the residual impact (i.e., with mitigation) identified. Secondary mitigation measures are described below and have been developed through ongoing engagement with statutory authorities as part of the statutory consultation process.

Underwater noise and vibration on fish and marine mammals as a result of construction

9.9.3 In order to reduce the level of impact associated with underwater noise and vibration on fish and marine mammals during construction (which is assessed as minor to moderate adverse), the following mitigation measures will be implemented during piling:

- **Soft start:** The gradual increase of piling power, incrementally, until full operational power is achieved will be used as part of the piling methodology. This will give fish and marine mammals the opportunity to move away from the area before the onset of full impact strikes. The duration of the soft start is proposed to be 20 minutes in line with the JNCC piling protocol [39];

- **Vibro piling**: Vibro piling is proposed to be used where possible (which produces lower peak source noise levels than percussive piling);

- **Seasonal piling restrictions:** During percussive piling the following further restrictions are proposed:
  - No percussive piling is to take place within the waterbody between 1 April and 31 May inclusive in any calendar year. This will minimise the potential impact on the greatest number of different migratory fish in the Humber Estuary, in accordance with the periods identified in Table 9.16, and also the more vulnerable earlier life stages of a number of migratory fish species[40]. This restriction does not apply to percussive

[39] JNCC (2010). Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise.

[40] Spring is the peak period when Atlantic salmon and sea trout smolts migrate downstream to the sea and it is also the peak migration period for European eel elvers moving into the estuary. In addition, it is the period when allis shad move into estuaries and when sea lamprey and twaite shad gather in estuaries and move up to spawn. It is also the period when the highest densities of smelt are present in the Humber Estuary.

piling that can be undertaken outside the waterbody at periods of low water[41];

- The duration of percussive piling is to be restricted within the waterbody from 1 June to 30 June and 1 August to 31 October inclusive in any year to minimise the impacts on fish migrating through Humber Estuary during this period such as silver eels, river lamprey and returning adult Atlantic salmon. The maximum amount of percussive piling permitted within any 4-week period must not exceed 140 hours where a single piling rig is in operation or a total of 196 hours where two or more rigs are in operation. The measurement of time during each work-block described above must begin at the start of each timeframe, roll throughout it, then cease at the end, where measurement will begin again at the start of the next timeframe, such process to be repeated until the end of piling works. This restriction does not apply to percussive piling that can be undertaken outside the waterbody at periods of low water. This approach has been developed in consultation with the MMO and Cefas;

- **Night time piling restriction:** The upstream migration of river lamprey takes place almost exclusively at night (Environment Agency, 2013). There is also an increase in glass eel migratory activity during the night time (Harrison *et al.,* 2014). No percussive piling is to take place within the waterbody between 1 March to 31 March, 1 June to 30 June and 1 August to 31 October inclusive after sunset and before sunrise on any day. Percussive piling operations that have already been initiated will, however, be completed where an immediate cessation of the activity would form an unsafe working practice. This restriction does not apply to percussive piling that can be undertaken outside the waterbody at periods of low water which will limit the potential effects of underwater piling noise on the nocturnal movements of river lamprey and glass eels;
- **Marine Mammal Observer**: In addition, in order to further reduce the significance of the impact to marine mammals the JNCC "Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals during piling" (JNCC, 2010) will be followed during percussive piling. The key procedures highlighted in this document include the following:
  - Establishment of a 'mitigation zone' of 500 m from the piling locations, prior to any percussive piling. Within this mitigation zone, observations of marine mammals will be undertaken by a trained member of the construction team using marine mammal identification resources;

[41] The force generated by piling outside the waterbody will be exerted on the ground at that location. The sound waves can travel outwards through the seabed or be reflected from deeper sediments. As these waves propagate, sound will also "leak" upwards contributing to the airborne sound wave. The underwater noise from piling outside the waterbody will, therefore, be considerably reduced (and negligible in scale) as a result of absorption of the sound by the ground and air, the interaction with the ground surface (reflection and scattering), and the interaction with and transmission through the ground.

- 30 minutes prior to the commencement of percussive piling, a search should be undertaken by the Marine Mammal Observer to determine that no marine mammals are within the mitigation zone. Percussive piling activity should not be commenced if marine mammals are detected within the mitigation zone or until 20 minutes after the last visual detection;

- During percussive piling, the Marine Mammal Observer should observe the mitigation zone to determine that no marine mammals are within this area. Construction workers will be alerted if marine mammals are identified, and piling will cease whilst any marine mammals are within the mitigation zone. Piling can recommence when the marine mammal exits the mitigation zone and there is no further detection after 20 minutes; and

- If there is a pause in percussive piling operations for any reason over an agreed period of time, then another search (and soft-start procedures for piling) should be repeated before activity recommences. If, however, the mitigation zone has been observed while piling has ceased and no marine mammals have entered the zone, piling activity can recommence immediately.

9.9.4 Taking into account the mitigation measures described above, the residual effects for underwater noise and vibration during construction on fish and marine mammals are assessed as **minor adverse** and not significant.

Disturbance to coastal waterbirds during construction

9.9.5 In order to reduce the level of impact associated with noise and visual disturbance during construction (which was assessed on a worst case basis, as moderate to major adverse), the following mitigation measures will be implemented during construction:

- **Winter marine construction restriction from 1 October to 31 March (approach jetty and the inner finger pier):** In order to minimise potential disturbance effects on wintering populations of coastal waterbirds on the foreshore it is proposed that marine construction activity associated with the approach jetty, linkspan, innermost pontoon and the inner finger pier (see Figure 1.2 to this ES) which are all located on or close (within approximately 200 m) to the intertidal mudflat is prohibited during the winter months of October to March. This restriction applies until an acoustic barrier/visual screen has been installed on both sides of the semi-completed structure. Construction activity will then be undertaken on the approach jetty itself, behind the screens, with no use of large heavy plant. With the addition of acoustic barriers, noise levels on the intertidal mudflat will be less than 65 dB(A). Construction activity associated with the seaward section of the approach jetty, linkspan, innermost pontoon and inner finger pier can also occur two hours before and two hours after high water, when works are approximately 200 m from the exposed mudflat. A noise suppression system will also be used for piling. The noise

suppression system is predicted to reduce noise levels to <70 dB *L*max at distances greater than approximately 200 m from the piling;

- **Noise suppression system for piling on the outer finger pier:** It is proposed that a noise suppression system (consisting of a piling sleeve with noise insulating properties) is used during all percussive piling activities for the outer finger pier to reduce noise levels on nearby foreshore areas;

- **Acoustic barrier/screening on marine construction barges**: To limit disturbance during construction, it is proposed that an acoustic barrier/screening is placed on the side of the floating barges closest to the foreshore and construction activity should only be undertaken from the side of the barge facing away from the foreshore. This will be applied to floating barges used for all construction works including the outer finger pier during the over wintering period;

- **Soft starts:** Using soft starts (as outlined in the marine mammal and fish section above) will allow birds to become more tolerant to piling noise by allowing a more gradual increase in noise levels which will reduce the potential for birds to become startled. This will be applied to all piling activity including the outer finger pier; and

- **Cold weather construction restriction**: Coastal waterbirds are considered particularly vulnerable to bird disturbance during periods of extreme winter weather[42]. On this basis, it is proposed that a temporary cessation of all construction activity is implemented following seven consecutive days of freezing (zero or sub-zero temperature) weather conditions. The restriction should not be lifted until after 24 hours of above freezing temperatures and also that Metrological Office weather forecasts indicate that freezing conditions will not return for the next five days. Similar measures have been implemented for other nearby developments and also as part of the JNCC scheme to reduce disturbance to waterfowl due to shooting activity during severe winter weather.

9.9.6 Taking into account the mitigation measures described above, the residual effects for noise and visual disturbance during construction on coastal waterbirds are assessed as **minor adverse** and not significant.

[42] It is recognised that during cold periods, coastal waterbirds are more susceptible to disturbance due to higher energetic costs and greater feeding requirements for thermoregulation. Furthermore, very cold winter weather can cause mudflats and adjacent functionally linked terrestrial habitats used for feeding (such as agricultural land and wet grassland) to freeze. In addition, cold conditions can also cause an influx of waterbirds from continental Europe which have flown to Britain to escape from even colder conditions in these areas. This can further increase competition for feeding resources in an area. The increased difficulty obtaining enough food and greater energy required for thermoregulation can in some situations cause reduced survival rates and appear to make birds seem more tolerant to disturbance as birds avoid using excess energy reserves (Goss-Custard, *et al*., 2006; JNCC, 2021, RSPB, 2010; Collop *et al*., 2016; Davidson and Rothwell,1993).

Disturbance to coastal waterbirds (operation)

9.9.7 The potential effects of disturbance during operation have been assessed as **minor.** On a precautionary basis, however, in order to reduce potential visual disturbance stimuli to waterbirds on the foreshore, screening will be installed so that movements of workers or vehicles will not be as visible from the foreshore. The use of screens is considered likely to be most effective initially during operation when birds are less likely to be as habituated to the new sources of noise and visual disturbance stimuli. Over time as the birds are expected to become habituated to such disturbance events and as such a phased removal of the screens is proposed after 2 years.

9.9.8 Screens (such as fences and other barriers) are a widely used measure to help reduce potential disturbance to coastal waterbirds (Ikuta and Blumstein, 2003; Liley and Tyldesley, 2013; Hockin *et al*., 1992) and has been successfully applied as mitigation to reduce disturbance at a number of operational berthing facilities in port locations located near intertidal waterbird populations (GoBe Consultants Ltd, 2011, ABPmer, 2014; MMO, 2018).

9.9.9 Screening will be installed either side of the linkspan and approach jetty. These screens should be opaque or made out of material that distorts outlines of anthropogenic activity on the infrastructure. It is noted that some gaps might be required in the screens for engineering reasons and to allow for emergency sight lines and access.

9.9.10 Coastal waterbird monitoring will also be undertaken based on the same sectors and approach as the current IOH surveys for the first two years of operation (paragraph 9.6.80). This will include recording any bird disturbance observed during the surveys. The results of these surveys will be summarised as part of an annual report.

Tertiary mitigation

9.9.11 Tertiary mitigation measures will be undertaken to manage commonly occurring environmental effects. Although these are not likely to alter the assessment conclusions, they are considered to be standard good practice. These are as follows:

- **Even disposal deposition of dredged material**: Targeting disposal loads in the central/deeper area of the disposal sites to reduce depth reductions. This will minimise the initial reduction in water depth and any environmental changes at the disposal sites;
- **Following biosecurity management procedures**: Biosecurity control measures during construction have been included within the CEMP (Application Document Reference number 9.2) and ABP's existing biosecurity management procedures will be followed during operation; and
- **Adhering to environmental management best practice**: The potential risk from accidents and spillages/leaks during construction will be avoided or minimised by ensuring that the construction methods, proposed design and the contractual arrangements follow pollution prevention legislation

and environmental management best practice (see Section 3.3 of Chapter 3 Details of Project Construction and Operation of this ES).

9.10 Limitations and assumptions

9.10.1 This assessment has been undertaken based on the following assumptions:

- The scheme design and project methodology, as detailed in Chapter 2 and 3 of this ES;
- The underwater noise assessment assumes that two piling rigs with impact hammers will be used concurrently as a worst case;
- The underwater noise assessment assumes that the dredging and vessel activity will take place continuously (24/7) and as such, provides a precautionary assessment; and
- The underwater noise assessment assumes that marine mammals will evade the noise source.

9.10.2 Whilst these are assumptions, the assessment within this ES has been undertaken considering the anticipated worst-case scenario in respect of marine ecology receptors at the dredge, piling and disposal locations.

9.11 Residual effects and conclusion

9.11.1 A summary of the impact pathways that have been assessed, the identified residual impacts and level of confidence is presented in Table 9.26 of this chapter. These addressed the potential for impacts on nature conservation and marine ecology receptors during construction and operation.

9.11.2 Specific mitigation measures are proposed with respect to the following potential effects:

- Underwater noise and vibration on fish and marine mammals as a result of piling; and
- Noise and visual disturbance to coastal waterbirds during construction.

9.11.3 Without mitigation, potential effects on these receptors were assessed as **minor to moderate adverse** (underwater noise on fish and marine mammals due to piling) and **minor to major adverse** (disturbance to coastal waterbirds during construction). The residual effects on these receptors assessed as **minor** and not significant following the implementation of the proposed mitigation measures.

9.11.4 All the other potential impacts on nature conservation and marine ecology receptors have been assessed as **insignificant to minor adverse** and, therefore, not significant.

Table 9.26. Summary of potential impact, mitigation measures and residual impacts

Receptor	Impact pathway	Impact Significance	Mitigation	Residual Impact	Confidence
Construction Phase					
Benthic habitats and species	Direct loss of intertidal habitat as a result of capital dredging and piles	Insignificant		Insignificant	Medium
	Direct loss of subtidal habitat as a result of the piles	Insignificant		Insignificant	High
	Changes to benthic habitats and species as result of the removal of seabed material during dredging	Insignificant to minor		Insignificant to minor	High
	Changes to habitats and species as a result of sediment deposition during dredging and dredge disposal	Insignificant	Target disposal loads in the central/ deeper area of the disposal sites to reduce depth reductions	Insignificant	Medium
	Indirect loss or change to seabed habitats and species as a result of changes to hydrodynamic and sedimentary processes during capital dredging and dredge disposal	Insignificant		Insignificant	Medium
	Changes in water and sediment quality during capital dredging and dredge disposal	Insignificant		Insignificant	Medium
	Underwater noise and vibration during piling, capital dredging and dredge disposal	Insignificant		Insignificant	Medium
	Introduction and spread of non-native species	Insignificant to minor adverse	Include biosecurity control measures within the CEMP	Insignificant to minor	Medium

Receptor	Impact pathway	Impact Significance	Mitigation	Residual Impact	Confidence
Fish	Direct loss or changes to fish populations and habitat as a direct result of dredging and dredge disposal	Insignificant to minor		Insignificant	Medium
	Changes in water and sediment quality as a result of dredging and dredge disposal	Insignificant		Insignificant	Medium
	Underwater noise disturbance and vibration during piling, capital dredging and dredge disposal	Minor to moderate (migratory fish during piling) Insignificant to minor (other fish species during piling) Insignificant to minor (dredge and dredge disposal)	Apply soft start procedures during piling Use vibro piling where possible Seasonal piling restrictions Night time working restriction	Insignificant to minor	Medium
Marine mammals	Underwater noise disturbance and vibration during piling, capital dredging and dredge disposal	Minor to moderate (piling) Insignificant (dredge and dredge disposal)	Apply soft start procedures during piling Use vibro piling where possible Marine Mammal Observer will follow JNCC protocol to minimise the risk of injury to marine	Minor	Medium

Receptor	Impact pathway	Impact Significance	Mitigation	Residual Impact	Confidence
			mammals during percussive piling		
Coastal waterbirds	Loss or change to coastal waterbird habitat	Insignificant		Insignificant	Medium
	Noise and visual disturbance	Inner finger pier and approach jetty: Minor (low sensitivity species) to moderate to major (high sensitivity species); Outer finger pier: Minor (low sensitivity species) to moderate (high sensitivity species); and Capital dredge: Negligible (all species).	Winter marine construction restriction for certain aspects of the inner pier and approach jetty works (1 October to 31 March) Noise suppression system for piling on the outer finger pier Acoustic barrier/visual screen on approach jetty from 1 October to 31 March Acoustic barrier/screening on marine construction barges	Minor	Medium

Receptor	Impact pathway	Impact Significance	Mitigation	Residual Impact	Confidence
			Apply soft start procedures during piling Cold weather construction restriction (all construction activity)		
Operational Phase					
Benthic habitats and species	Changes to benthic habitats and species as result of seabed removal during maintenance dredging	Insignificant to minor		Insignificant to minor	Medium
	Direct changes to benthic habitats and species beneath marine infrastructure due to shading	Insignificant		Insignificant	Medium
	Changes to intertidal habitats and species as a result of the movement of Ro-Ro vessels during operation	Insignificant		Insignificant	Medium
	Non-native species transfer during vessel operations	Insignificant to minor		Insignificant to minor	Medium
Coastal waterbirds	Direct changes to foraging and roosting habitat as a result of the presence of infrastructure	Minor		Minor	Medium
	Disturbance of waterbirds during operation	Minor	Screening	Minor	Medium

9.12 References

Aage, C., Bell, A.K., Bergdahl, L., Blume, A., Bolt, E., Eusterbarkey, H., Tetsuya, H., Kofoed-Hansen, H., Maly, D., Single, M. and Rytkönen, J. (2003). Guidelines for managing wake wash from high-speed vessels. PIANC.

Aarts, G., Brasseur, S. & Kirkwood, R. (2017) Response of grey seals to pile-driving. Wageningen, Wageningen Marine Research (University & Research centre), Wageningen Marine Research report C006/18. 54 pp.

Able UK Limited. (2021). Able Marine Energy Park (Material Change 2 – Tr030006). Updated Environmental Statement: Chapter 10: Aquatic Ecology.

Associated British Ports (ABP) Research (1999) Good Practice Guidelines for Ports and Harbours Operating Within or Near UK European Marine Sites. English Nature, UK Marine SACs Project. ABP Research & Consultancy Ltd, pp 120.

ABP Research. (2000). The Marine Environment Impact Identification and Evaluation TS/ME7. ABP Southampton: Dibden Terminal, Associated British Ports, Southampton, ABP Research & Consultancy Ltd, Research Report No. R.782

ABP Research. (2001). ABP Grimsby & Immingham, Immingham Outer Harbour Environmental Statement. ABP Research & Consultancy Ltd, Report No. R.903.

ABPmer. (2002). ABP Teignmouth Quay Development Environmental Statement. ABP Marine Environmental Research Ltd, Report No. R.984a.

ABPmer. (2009). Humber Estuary: Environmental Management and Monitoring Plan: Data 2009. R. 1587.

ABPmer. (2013). Bury Marsh Bird Monitoring 2012-2014: Interim Report. ABP Marine Environmental Research Ltd, Report No. R.2123.

ABPmer (2014). Bird Disturbance Monitoring of the 'RWE Pontoon' at the Port of Mostyn. First Yearly Summary: October 2013 to March 2014. Gwynt y Môr Offshore Wind Farm Ltd

ABPmer, (2015). Bird Disturbance Monitoring of the 'RWE Pontoon' at the Port of Mostyn: Review of Two Year Monitoring Programme (2013 to 2015). ABP Marine Environmental Research Ltd, Report No. R.2320.

ABPmer, (2017). Benthic monitoring at HU056 (data unpublished).

ABPmer (2021). Bathside Bay Bird Monitoring, First Annual Report – September 2020 to June 2021, ABPmer Report No. R.3714. A report produced by ABPmer for Galloper Wind Farm Limited, October 2021.

Alabaster, J.S. (1993). River Usk Barrage Order 1993. Proof of Evidence on Pollution and Fisheries.

Ashley, M. (2016). [Nephtys hombergii] and [Streblospio shrubsolii] in littoral mud. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, Plymouth: Marine Biological Association of the United Kingdom. [Online] Available at: [redacted]

Ashley, M. and Budd, G.C. (2020). [Hediste diversicolor] and [Corophium volutator] in littoral mud. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Review, Plymouth: Marine Biological Association of the United Kingdom. [Online] Available at: [redacted]

Austin, G and Ross-Smith, V. (2014). Guidance to Interpretation of Wetland Bird Survey Within-Site Trends. BTO Research Report No. 661.

Barsiene, J. (1994). Chromosome set changes in molluscs from highly polluted habitats, in: A.R. Beaumont. Ed. Genetics and Evolution of Aquatic Organisms, Chapman & Hall, London. pp.434–447.

Belanger, L. and Bedard, J. (1990). Energetic cost of man-induced disturbance to staging snow geese. Journal of Wildlife Management, 54, pp.36-41.

Blockley, D.J. and Chapman, M.G. (2006). Recruitment determines differences between assemblages on shaded or unshaded seawalls. Marine Ecology Progress Series, 327, pp.27-36.

Blockley, D.J. (2007). Effect of wharves on intertidal assemblages on seawalls in Sydney Harbour, Australia. Marine environmental research, 63(4), pp.409-427.

Bolam, S.G., Rees, H.L., Somersfield, P., Smith, R., Clarke, K.R., Warwick, R.M., Atkins, M., and Bradbury, A. P., Colenutt, A. J., Cross, J., Eastick, C., and Hume, D. (2003). Evaluation of Coastal Process Impacts Arising from Nearshore Aggregate Dredging for Beach Recharge–Shingles Banks, Christchurch Bay. In International Conference on Coastal Management 2003: Proceedings of the International Conference on Coastal Management, Organised by the Institution of Civil Engineers and Held in Brighton, UK, on 15-17 October 2003. p.98.

Bolam, S.G., Schratzberger, M. and Whomersley, P. (2004). Macrofaunal recolonization in intertidal mudflats: the effect of organic content and particle size. Journal of Experimental Marine Biology and Ecology, 306.

Bolam, S.G., Schratzberger, M. and Whomersley, P. (2006a). Macro- and meiofaunal recolonization of dredged material used for habitat enhancement: Temporal patterns in community development. Marine Pollution Bulletin, 52, pp.1746-1755.

Bolam, S.G., Rees, H.L., Somersfield, P., Smith, R., Clarke, K.R., Warwick, R.M., Atkins, M. and Garnacho, E. (2006b). Ecological consequences of dredged material disposal in the marine environment: A holistic assessment of activities around the England and Wales coastline. Marine Pollution Bulletin, 52, pp.415-426.

Bolam, S.G., McIlwaine, P.S.O. and Garcia, C. (2016). Application of biological traits to further our understanding of the impacts of dredged material disposal on benthic assemblages. Marine Pollution Bulletin, 105(1), pp.180-192.

Borja, Á., Belzunce, M.J., Garmendia, J.M., Rodríguez, J.G., Solaun, O. and Zorita, I. (2012). Impact of Pollutants on Coastal and Benthic Marine Communities. Ecological Impacts of Toxic Chemicals, 165.

Bowgen, K.M. (2016). Predicting the effect of environmental change on wading birds: insights from individual-based models.

Boyd, S.E., Cooper, K.M., Limpenny, D.S., Kilbride, R., Rees, H.L., Dearnaley, M.P., Stevenson, J., Meadows W.J. and Morris, C.D. (2004). Assessment of the re-habilitation of the seabed following marine aggregate dredging. Sci. Ser. Tech. Rep., Cefas Lowestoft, 121, p.154.

Bradbury, A.P., Colenutt, A.J., Cross, J., Eastick, C. and Hume, D. (2003). Evaluation of coastal process impacts arising from nearshore aggregate dredging for beach recharge - Shingles Bank, Christchurch Bay. p.15.

Brandt, M., Diederichs, A., Betke, K. and Nehls, G. (2011). Responses of harbour porpoises to pile driving at the Horns Rev II offshore wind farm in the Danish North Sea. Marine Ecology Progress Series, 421, pp.205–216.

Britwell, I.K. (2000). Effects of sediment on fish and their habitat, DFO Pacific Region, Habitat status report 2000/01 E, Canada.

Britwell, I. K. (2000). Effects of Sediment on Fish and Their Habitat, DFO Pacific Region, Habitat Status Report 2000/01 E, Canada.

Budd, G.C. (2004). Burrowing amphipods and Eurydice pulchra in well-drained clean sand shores. Marine life information network: Biology and sensitivity key information subprogramme, Plymouth, Marine Biological Association of the United Kingdom. [Online] Available at: [redacted] (accessed January 3, 2005).

Burger, J. and Gochfeld, M. (1998). Effects of ecotourists on bird behaviour at Loxahatchee National Wildlife Refuge, Florida. Environmental Conservation, 25, 13-21.

Burton, N. H. (2000). Winter site-fidelity and survival of Redshank Tringa totanus at Cardiff, south Wales. Bird Study, 47(1), 102-112.

Burton, N.H., Rehfisch, M.M., and Clark, N.A. (2002a). Impacts of disturbance from construction work on the densities and feeding behavior of waterbirds using the intertidal mudflats of Cardiff Bay, UK. Environmental Management, 30(6), pp.0865-0871.

Burton, N. H., Armitage, M. J., Musgrove, A. J., & Rehfisch, M. M. (2002b). Impacts of man-made landscape features on numbers of estuarine waterbirds at low tide. Environmental Management, 30(6), 0857-0864.

Burton, N.H.K., Rehfisch, M.M., Clark, N.A. and Dodd, S.G. (2006). Impacts of sudden winter habitat loss on the body condition and survival of redshank Tringa totanus. Journal of Applied Ecology, 43, pp.464–473.

Byers, J.E. and Grabowski, J.H. (2014). Soft-sediment communities. Marine Community Ecology. Sinauer, pp.227-249.

Calladine J.R., Park, K.J, Thompson, K. and Wernham, C.V. (2006). Review of Urban Gulls and their Management in Scotland. A report to the Scottish Executive.

Camphuysen, C. J., & Webb, A. (1999). Multi-species feeding associations in North Sea seabirds: jointly exploiting a patchy environment. ARDEA-WAGENINGEN-, 87(2), 177-198.

Carlton, J.T. (1992). Marine Species Introductions by Ships' Ballast Water: An Overview. In: Proceedings of the Conference and Workshop on Introductions and Transfers of Marine Species: Achieving a Balance Between Economic Development and Resource Protection, Hilton Head Island, South Carolina October 30 – November 2, 1991, ed. By M.R. De Voe. pp.23-25. South Carolina Sea Grant Consortium.

Carlton, J.T., and Geller, J.B. (1993). Ecological Roulette: The Global Transport of Nonindigenous Marine Organisms. Science, 261, pp.78-82.

Carrol., A.G., Przeslawski, R., Duncan, A., Gunning, M. and Bruce, B. (2017). A critical review of the potential impacts of marine seismic surveys on fish & invertebrates. Marine Pollution Bulletin, 114, pp.9-24.

Carter, M.I., Boehme, L., Duck, C.D., Grecian, J., Hastie, G.D., McConnell, B.J., Miller, D.L., Morris, C., Moss, S., Thompson, D. and Thompson, P. (2020). Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles: Report to BEIS, OESEA-16-76, OESEA-17-78.

Catalano, B., Moltedo, G., Martuccio, G., Gastaldi, L., Virno-Lamberti, C., Lauria, A. and Ausili, A. (2012). Can Hediste diversicolor (Nereidae, Polychaete) be considered a good candidate in evaluating PAH contamination? A multimarker approach. Chemosphere, 86(9), pp.875-882.

Centre for Environment, Fisheries and Aquaculture Science (Cefas) (2016). Suspended Sediment Climatologies around the UK. Report for the UK Department for Business, Energy & Industrial Strategy offshore energy Strategic Environmental Assessment programme.

CEDA. (2011). Underwater sound in relation to dredging. CEDA Position Paper - 7 November 2011.

Cefas. (2012). ME1101. Development of Approaches, Tools and Guidelines for the Assessment of the Environmental Impact of Navigational Dredging in Estuaries and Coastal Waters: Literature Review of Dredging Activities: Impacts, Monitoring and Mitigation.

Cefas. (2020). The Sizewell C Project: Volume 2 Main Development Site Chapter 22 Marine Ecology and Fisheries Appendix 22L – Underwater noise effects assessment for Sizewell C: Edition 2. Revision 1.0. May 2020.

Cefas. (2021). Shellfish Classification Zones of England and Wales. [Online] Available at: [redacted]

Cetacean Strandings Investigation Programme (CSIP). (2020). Annual Report for the period 1st January – 31st December 2018 (Contract number ME6008).

Carstensen, J., Henriksen, O.D. and Teilmann, J. (2006). Impacts of offshore wind farm construction on harbour porpoises: Acoustic monitoring of echolocation activity using porpoise detectors (T-PODs). Marine Ecology Progress Series, 321, pp.295–308.

Chartered Institute of Ecology and Environmental Management (CIEEM). (2018). Guidelines for Ecological Impact Assessment in the UK and Ireland. [Online] Available at: [redacted]

Christian, J.R., Mathieu, A., Thompson, D.H.,White, D., Buchanan, R.A. (2003). Effect of Seismic Energy on SnowCrab (*Chionoecetes opilio*). Environmental Funds Project No. 144. Fisheries and Oceans Canada. Calgary (106p).

Coleman, R.A., Salmon, N.A and Hawkins, S.J. (2003). Sub-dispersive human disturbance of foraging oystercatchers Haematopus ostralegus. Ardea, 91, pp.263-268.

Collop, C., Stillman, R.A., Garbutt, A., Yates, M.G., Rispin, E., and Yates, T. (2016). Variability in the area, energy and time costs of wintering waders responding to disturbance. Ibis, 158(4), pp.711-725.

Cook, E.J., Macleod, A. Payne, R.D., and Brown, S (2014) (edited by Natural England and Natural Resources Wales in 2015). Marine Biosecurity Planning - Guidance for producing site and operation-based plans for preventing the introduction and spread of non-native species in England and Wales. Available online at: [redacted] [accessed 30/11/2021]

Cox, R., Wadsworth, R.A. and Thomson, A.G. (2003). Long-term changes in salt marsh extent affected by channel deepening in a modified estuary. Continental Shelf Research, 23(17-19), pp.1833-1846.

Cundy, A.B., Hopkinson, L., Lafite, R., Spencer, K., Taylor, J.A., Ouddane, B., Heppell, C.M., Carey, P.J., Charman, R., Shell, D., Ullyott, S. (2005). Heavy metal distribution and accumulation in two Spartina sp.-dominated macrotidal salt marshes from the Seine estuary (France) and the Medway estuary (UK). Applied Geochemistry 20, 1195–1208.

Curtin, S., Richards, S., Westcott, S. (2009). Tourism and grey seals in South Devon: management strategies, voluntary controls and tourists' perception of disturbance. Current Issues in Tourism, 12(1), 59-81.

Cutts, N.D (2021), Nseleni Independent Floating Power Plant (NIFPP) EIA. Provision of Professional Opinion on Waterbird Disturbance Potential: Audible and Visual Stimuli Impacts and Mitigation Measures. Cutts & Hemingway Estuarine Ecology and Management Ltd. (CHEEM), UK. Report to SE Solutions (Pty) Ltd, South Africa; Report No. CHEEM019-F2-2021.

Dähne, M., Gilles, A., Lucke, K., Peschko, V., Adler, S., Krügel, K. and Sundermeyer, J. (2013). Effects of pile-driving on harbour porpoises (Phocoena phocoena) at the first offshore wind farm in Germany. Environmental Research Letters, 8(2), 0.025002

Davidson, N. C., & Rothwell, P. I. (1993). Human disturbance to waterfowl on estuaries: conservation and coastal management implications of current knowledge. Wader study group bulletin, 68, 97-105.

Day, R.D., McCauley, R., Fitzgibbon, Q.P., Semmens, J.M. (2016). Assessing the Impact of Marine Seismic Surveys on Southeast Australian Scallop and Lobster Fisheries. (FRDC Report 2012/008) University of Tasmania, Hobart.

Dauvin, J.C. (2008). Effects of heavy metal contamination on the macrobenthic fauna in estuaries: The case of the Seine estuary. Marine Pollution Bulletin, 57, pp.160-169.

De-Bastos, E.S.R. (2016a). [Kurtiella bidentata] and [Abra] spp. in infralittoral sandy mud. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, Plymouth: Marine Biological Association of the United Kingdom. [Online] Available at: [redacted]

De-Bastos, E.S.R. (2016b). [Nephtys hombergii] and [Tubificoides] spp. in variable salinity infralittoral soft mud. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, Plymouth: Marine Biological Association of the United Kingdom. [Online] Available at: [redacted]

De-Bastos, E.S.R. & Hill, J., 2016. Polydora ciliata and Corophium volutator in variable salinity infralittoral firm mud or clay. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 17-05-2022]. Available from: [redacted]

De-Bastos, E. and Hiscock, K. (2016). [Aphelochaeta marioni] and [Tubificoides] spp. in variable salinity infralittoral mud. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, Plymouth: Marine Biological Association of the United Kingdom. [Online] Available at: [redacted]

Defew, E.C., Perkins, R.G. and Paterson, D.M. (2004). The influence of light and temperature interactions on a natural estuarine microphytobenthic assemblage. Biofilms, 1(1), pp.21-30.

Deloffre, J., Lafite, R., Lesueur, P., Lesourd, S., Verney, R. and Guézennec, L. (2005). Sedimentary processes on an intertidal mudflat in the upper macrotidal Seine estuary, France. Estuarine, Coastal and Shelf Science, 64(4), pp.710-720.

Department of Energy and Climate Change (DECC). (2016). UK Offshore Energy Strategic Environmental Assessment 3: Future Leasing for Offshore Wind Farms and Licensing for Offshore Oil & Gas and Gas Storage. Department for Energy and Climate Change.

Diederichs, A., Brandt, M.J., Betke, K. and Nehls G. (2011). Responses of harbour porpoises to pile driving at the Horns Rev II offshore wind farm in the Danish North Sea. Marine Ecological Progress Series, 421, pp.205-216.

Durell, S.E.A. le V. dit, Stillman, R.A., Triplet, P., Aulert, C., Bio, D.O. dit, Bouchet, A., Duhamel, S., Mayot, S. and Goss-Custard, J.D. (2005). Modelling the efficacy of proposed mitigation areas for shorebirds: a case study on the Seine estuary, France. Biological Conservation, 123, pp.67–77.

Dwyer, R.G. (2010). Ecological and anthropogenic constraints on waterbirds of the Forth Estuary: population and behavioural responses to disturbance. Thesis submitted as candidature for the degree of Doctor of Philosophy Centre for Ecology and Conservation.

Dyer, K.R. (1994). Estuarine sediment transport and deposition. Sediment transport and depositional processes, pp.193-218.

Elliott, M., Nedwell, S., Jones, N.V., Read, S.J., Cutts, N.D. and Hemmingway, K.L. (1998). Intertidal sand and mudflats & subtidal mobile sandbank Volume II. An overview of dynamics and sensitivity characteristics for conservation management of marine SACs. Scottish Association of Marine Science UK Marine SACs Project 151pp.

Elliott, M. and Marshall, S. (2000). The Biology of Fishes of the Humber Estuary, UK. Coastal Zone Topics: Process, Ecology & Management, 4, pp.85-96.

Elliott, M., Whitfield, A.K., Potter, I.C., Blaber, S.J.M., Cyrus, D.P., Nordlie, F.G. and Harrison, T.D. (2007). The guild approach to categorizing estuarine fish assemblages: a global review. Fish and Fisheries, 8(3), pp.241–268.

Ellis, J.R., Milligan, S.P., Readdy, L., Taylor, N. and Brown, M.J. (2012). Spawning and nursery grounds of selected fish species in UK waters. Sci. Ser. Tech. Rep., Cefas Lowestoft, 147, 56.

English Nature. (2003). The Humber Estuary European Marine Site.

Environment Agency. (2013). Review of fish population data in the Humber Estuary. A report by the University of Hull for the Environment Agency.

Environment Agency. (2021). TraC Fish Counts for all Species for all Estuaries and all years. [Online] Available at: https://data.gov.uk/dataset/41308817-191b-459d-aa39-788f74c76623/trac-fish-counts-for-all-species-for-all-estuaries-and-all-years.

Erirf, A. and Soomere, T. (2004). Influence of fast ship waves on the optical properties of sea water in Tallinn Bay, Baltic Sea. In Proceedings of the Estonian Academy of Sciences, Biology and Ecology (Vol. 53, No. 3, pp. 161-178). Estonian Academy Publishers.

ERM. (1996). South Humber Power Station, Pyewipe, Bird Monitoring Study, April 1996.

Evans, P.G.H and Bertulli, C.G (2021). Cetaceans in the Humber Estuary Region. A report by the Seawatch Foundation to ABPmer.

Franco A., Elliott M., Franzoi P. and Torricelli P. (2008). Life strategies of fishes in European estuaries: the functional guild approach. Marine Ecology Progress Series, 354, pp.219-228.

Franco, A. Leighton, A. Bailey, M. Thomson, A and Musk, W. (2015). Humber Estuary SAC Intertidal Sediment Survey. IECS Report No. YBB249-F-2015. A report to Natural England.

Frost, T.M., Calbrade, N.A., Birtles, G.A., Hall, C., Robinson, A.E., Wotton, S.R., Balmer, D.E. and Austin, G.E. (2021). Waterbirds in the UK 2019/20: The Wetland Bird Survey. BTO/RSPB/JNCC. Thetford.

Gill, J.A., Norris, K. and Sutherland, W.J. (2001a). Why behavioural responses may not reflect the population consequences of human disturbance. Biological Conservation, 97, pp.265-268.

Glover, H.K., Guay, P.J., and Weston, M.A. (2015). Up the creek with a paddle; avian flight distances from canoes versus walkers. Wetlands Ecology and Management, pp.1-4.

GoBe Consultants Ltd (2011); Port of Mostyn – Wind Farm Service Vessel Pontoon Facility - Environmental Statement. Prepared for RWE Npower Renewables Ltd.

Goss-Custard, J.D., Triplet, P., Sueur, F., and West, A.D. (2006). Critical thresholds of disturbance by people and raptors in foraging wading birds. Biological Conservation, 127(1), pp.88-97.

Goss-Custard, J. D., Hoppe, C. H., Hood, M. J., and Stillman, R. A. (2020). Disturbance does not have a significant impact on waders in an estuary close to conurbations: importance of overlap between birds and people in time and space. Ibis, 162(3), pp.845-862.

Grabowski, R.C., Droppo, I.G. and Wharton, G. (2011). Erodibility of cohesive sediment: The importance of sediment properties. Earth-Science Reviews, 105(3-4), pp.101-120.

Granadeiro, J. P., Dias, M. P., Martins, R. C., & Palmeirim, J. M. (2006). Variation in numbers and behaviour of waders during the tidal cycle: implications for the use of estuarine sediment flats. Acta oecologica, 29(3), 293-300.

Grant, W.D. and Madsen, O.S. (1979). Combined wave and current interaction with a rough bottom. Journal of Geophysical Research: Oceans, 84(C4), pp.1797-1808.

Goodship, N. & Furness, R.W. (2019). Seaweed hand-harvesting: literature review of disturbance distances and vulnerabilities of marine and coastal birds. Scottish Natural Heritage Research Report No. 1096

Goodship, N.M. and Furness, R.W. (2022). Disturbance Distances Review: An updated literature review of disturbance distances of selected bird species. NatureScot Research Report 128

Guay, P.J., McLeod, E.M., Taysom, A.J., and Weston, M.A. (2014). Are vehicles 'mobile bird hides'?: A test of the hypothesis that 'cars cause less disturbance'. The Victorian Naturalist 131, pp.150-155.

Gunnarsson, T. G., Gill, J. A., Petersen, A., Appleton, G. F. and Sutherland, W. J. (2005). A double buffer effect in a migratory shorebird population. Journal of Animal Ecology, 74(5), pp.965–971.

Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Boerjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M., Scheidat, M. and Teilmann, J. (2021). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. Wageningen Marine Research.

Hannam, M.L., Bamber, S.D., Galloway, T.S., Moody, A.J. and Jones, M.B. (2010). Effects of the model PAH phenanthrene on immune function and oxidative stress in the haemolymph of the temperate scallop Pecten maximus. Chemosphere, 78(7), pp.779-784.

Harris, R.E., Miller, G.W. and Richardson, W.J. (2001). Seal responses to airgun sounds during summer seismic surveys in the Alaskan Beaufort Sea. Marine Mammal Science, 17, pp.795–812.

Harrison, A.J., Walker, A.M., Pinder, A.C., Briand, C. and Aprahamian, M.W., (2014). A review of glass eel migratory behaviour, sampling techniques and abundance estimates in estuaries: implications for assessing recruitment, local production and exploitation. Reviews in Fish Biology and Fisheries, 24(4), pp.967-983.

Hawkins, A.D., Roberts, L. and Cheesman, S. (2014). Responses of free-living coastal pelagic fish to impulsive sounds. The Journal of the Acoustical Society of America, 135.

Hawkins, A.D., Pembroke, A., and Popper, A. (2015). Information gaps in understanding the effects of noise on fishes and invertebrates. Reviews in Fish Biology and Fisheries, 25, pp. 39–64.

Hawkins A. D., and Popper, A. N. (2017). A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates. ICES Journal of Marine Science, Volume 74, Issue 3, 1 March 2017, Pages 635–651. [Online] Available at: [redacted]

Heessen, H.J., Daan, N., and Ellis, J.R. (Eds.). (2015). Fish atlas of the Celtic Sea, North Sea, and Baltic Sea: Based on international research-vessel surveys. Wageningen Academic Publishers.

Heinänen, S. and Skov, H. (2015). The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area, JNCC Report No. 544 JNCC, Peterborough.

Henry, E., & Hammill, M. O. (2001). Impact of small boats on the haulout activity of harbour seals (Phoca vitulina) in Metis Bay, Saint Lawrence Estuary, Quebec, Canada. Aquatic Mammals, 27(2), 140-148;

Hesselman, D.M., Blake, N.J. and Peters, E.C. (1988). Gonadal neoplasms in hard shell clams Mercenaria spp., from the Indian River, Florida: occurrence, prevalence, and histopathology. Journal of Invertebrate Pathology, 52(3), pp.436-446.

Hockin, D., Ounsted, M., Gorman, M., Keller, V., and Barker, M.A. (1992). Examination of the effects of disturbance of birds with reference to its importance in ecological assessments. Journal of Environmental Management. 36, pp.253-286.

Hoover-Miller, A., Bishop, A., Prewitt, J., Conlon, S., Jezierski, C., & Armato, P. (2013). Efficacy of voluntary mitigation in reducing harbor seal disturbance. The Journal of Wildlife Management.

Humber Nature Partnership. (2015). Humber Management Scheme 2015.

Institute of Environmental Management and Assessment (IEMA) (2016). Environmental Impact Assessment Guide to: Delivering Quality Development. Available at:

[redacted] accessed February 2022).

Ikuta, L. A., & Blumstein, D. T. (2003). Do fences protect birds from human disturbance?. Biological Conservation, 112(3), 447-452.

Institute of Estuarine and Coastal Studies (IECS). (1997). Saltend Development Cumulative Impact Study: Ornithological Impacts. Report to Consultants in Environmental Sciences Ltd. Report No. ZO80-97-F. IECS, University of Hull, 28p.

Institute of Estuarine and Coastal Studies (IECS). (2001). Impacts of sediment disturbance and deposition on intertidal biota. Final Report to English Nature September 2001.

Institute of Estuarine and Coastal Studies (IECS). (2009a). Construction and Waterfowl: Defining Sensitivity, Response, Impacts and Guidance. Institute of Estuarine and Coastal Studies Report to Humber INCA.

Institute of Estuarine and Coastal Studies (IECS). (2009b). Ornithological Monitoring, Saltend: Summary Trend Report #33 January 2007 to March 2007 Late Winter. Report to ABP Port of Hull. IECS, University of Hull.

Institute of Estuarine and Coastal Studies (IECS). (2010). South Humber Channel Marine Studies: Intertidal and Subtidal Benthic & Fish Surveys 2010: Report to Yorkshire Forward.

Institute of Estuarine and Coastal Studies (IECS) (2013). Waterbird Disturbance Mitigation Toolkit Informing Estuarine Planning and Construction Projects.

International Union for Conservation of Nature (IUCN). (2011). Invasive Species. [Online] Available at: [redacted] (accessed December 2020).

Jackson, M.V., Woodworth, B.K., Bush, R., Clemens, R.S., Fuller, R.A., Garnett, S.T., Lilleyman, A., Maron, M., Purnell, C., Rogers, D.I. and Amano, T., 2021. Widespread use of artificial habitats by shorebirds in Australia. Emu-Austral Ornithology, pp.1-10.

Jackson, M. V. (2017). Literature Review: Importance of artificial roosts for migratory shorebirds. Report to Charles Darwin University. Charles Darwin University: Darwin.

Johnson, L.L., Anulacion, B.F. and Arkoosh, M.R. (2014). Effects of legacy persistent organic pollutants (POPs) in fish – current and future challenges. In K. B. Tierney, A. P. Farrell and C. J. Brauner (Eds.), Organic chemical toxicology of fishes, fish physiology vol. 33 (pp. 53–140). London, UK: Academic Press.

Johnson, G.E.L., Caneco, B., Latto, P., Warner, I., Kaiser, M.J., and Donovan, C. (2017). Towards an understanding of the physical effects of natural disturbance and demersal fishing on UK mobile sediment MPAs. Defra contract ME6001.

Joint Nature Conservation Committee (JNCC). (2004). Common Standards Monitoring Guidance for Lowland Wetland, Version.

JNCC (2010). Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise.

JNCC. (2021). https://jncc.gov.uk/our-work/severe-weather-scheme/ Accessed November 2021.

JNCC, (2022a). https://jncc.gov.uk/jncc-assets/SAC-N2K/UK0030170.pdf. Accessed 4 March 2022

JNCC, (2022b). https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9006111.pdf Accessed 4 January 2022.

JNCC, (2022c). https://jncc.gov.uk/jncc-assets/RIS/UK11031.pdf Accessed 4 January 2022.

JNCC (2022d). https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9020329.pdf Accessed 28 January 2022.

Jones, D., and Marten, K. (2016). Dredging sound levels, numerical modelling and EIA. Terra et Aqua, 144, pp. 21-29.

Kingston, PF (2001). Benthic Organisms Review. In Encyclopedia of Ocean Sciences, 2nd Edition. Compiled by Steele, JS and edited by Steele, JS; Thorpe, SA & Turekian, KK.

Kjelland, M.E., Woodley, C.M., Swannack, T.M. and Smith, D.L. (2015). A review of the potential effects of suspended sediment on fishes: potential dredging-related physiological, behavioural, and transgenerational implications. Environment Systems and Decisions, 35(3), pp.334-350.

Koschinski, S., Culik, B.M., Henriksen, O.D., Tregenza, N., Ellis, G., Jansen, C. and Käthe, G. (2003). Behavioural reactions of free-ranging porpoises and seals to the noise of a simulated 2 MW windpower generator. Marine Ecology Progress Series, 265, pp.263–273.

Kudale, M. D. (2010). Impact of port development on the coastline and the need for protection. Indian Journal of Geo-Marine Sciences, 39(4), pp.597-604.

Lambeck, R.H.D. (1991). Changes in abundance, distribution and mortality of wintering oystercatchers after habitat loss in the Delta Area, SW Netherlands. Acta XX Congressus Internationalis, 4, pp.2208–2218.

Larsen, S.J., Kilminster, K.L., Mantovanelli, A., Goss, Z.J., Evans, G.C., Bryant, L.D. and McGinnis, D.F. (2019). Artificially oxygenating the Swan River estuary increases dissolved oxygen concentrations in the water and at the sediment interface. Ecological Engineering, 128, pp.112-121.

Lausen K.L., J. Kahlert & J. Frikke (2005). Factors affecting escape distances of staging waterbirds. Nordic Board for Wildlife Research.

Lees, PG., Kenny, A., and Pearson, R. (1992). The Condition of Benthic Fauna in Suction Dredger Outwash: Initial Findings. Annex Submitted to the Report of the ICES working group on the Effects of Extraction of Marine Sediments on Fisheries.

Levin, L.A., Ekau, W., Gooday, A.J., Jorissen, F., Middelburg, J.J., Naqvi, S.W.A. and Zhang, J. (2009). Effects of natural and human-induced hypoxia on coastal benthos. Biogeosciences, 6(10), pp.2063-2098.

Lincolnshire Environmental Records Centre (LERC). (2021). LERC Search Summary Report.

Liley, D. & Tyldesley, D. (2013). Solent Disturbance and Mitigation Project: Phase III. Towards an Avoidance and Mitigation Strategy. Unpublished report. Footprint Ecology/David Tyldesley & Associate people hidden from view to the bird.

Liley, D., Stillman, R. and Fearnley, H. (2010). The Solent Disturbance and Mitigation Project Phase II: Results of Bird Disturbance Fieldwork 2009/10. Footprint Ecology/Solent Forum.

Linssen., H., Van De Pol, M., Allen, A.M., Jans, M., Ens, B.J., Krijsveld, K.L., Frauendorf, M and Van der Kolk, H.J. (2019). Disturbance increases high tide travel distance of roosting shorebird but only marginally effects daily expenditure. Avian Research, 10(1), pp.1-11.

Long, E.R., MacDonald, D.D, Smith, S.L. and Calder, F.D. (1995). Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environmental Management, 191, pp.81-97.

MacDonald, D.D. and Ingersoll, C.G. (2010). Tools for assessing contaminated sediments in freshwater, estuarine, and marine ecosystems. Sedimentology of Aqueous Systems, pp.171-199.

McLeod, E. M., Guay, P. J., Taysom, A. J., Robinson, R. W., & Weston, M. A. (2013). Buses, cars, bicycles and walkers: the influence of the type of human transport on the flight responses of waterbirds. PLoS One, 8(12), e82008.

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

Maitland, P.S. and Hatton-Ellis, T.W., (2003). Ecology of the Allis and Twaite Shad. Conserving Natura 2000 Rivers Ecology Series No. 3. English Nature, Peterborough.

Mander, L., Marie-Orleach, L., and Elliott, M. (2013). The value of wader foraging behaviour study to assess the success of restored intertidal areas. Estuarine, Coastal and Shelf Science, 131, pp.1-5.

Mander, L., Scapin, L., Thaxter, C.B., Forster, R.M., & Burton, N.H. (2021). Long-Term Changes in the Abundance of Benthic Foraging Birds in a Restored Wetland. Frontiers in Ecology and Evolution, 584.

Mander, L., Nicholson, I., Green, R., Dodd, S., Forster, R. & Burton, N. (2022) Individual, sexual and temporal variation in the winter home range sizes of GPS-tagged Eurasian Curlews Numenius arquata, Bird Study, DOI: 10.1080/00063657.2022.2144129

Marine Aggregate Levy Sustainability Fund (MALSF). (2011). The Humber Regional Environmental Characterisation. Marine Aggregate Levy Sustainability Fund. British Geological Society Survey Open Report OR/10/54 MEPF 08/03.

Marine Climate Change Impact Partnership (MCCIP). (2020). Marine Climate Change Impacts: Report Card 2020.

Marine Ecological Surveys Ltd. (2008). Marine Macrofauna Genus Trait Handbook.

Marshall, S. and Elliott, M. (1997). The structure of the fish assemblage in the Humber estuary, United Kingdom. Oceanographic Literature Review, 10(44), p.1171.

Martín, B., Delgado, S., Cruz, A., Tirado, S., and Ferrer, M. (2014). Effects of human presence on the long-term trends of migrant and resident shorebirds: evidence of local population declines. Animal Conservation, 18, pp.73–81.

Mathews, E. A., Jemison, L. A., Pendleton, G. W., Blejwas, K. M., Hood, K. E., & Raum-Suryan, K. L. (2016). Haul-out patterns and effects of vessel disturbance on harbor seals (Phoca vitulina) on glacial ice in Tracy Arm, Alaska. Fishery Bulletin, 114(2);

McConnell, B.J., Fedak, M. A., Lovell, P., and Hammond P.S. (1999). Movements and Foraging Areas of Grey Seals in the North Sea. Journal of Applied Ecology, 36, pp.573-590.

McLeod, E.M., Guay, P.J., Taysom, A.J., Robinson, R.W., and Weston, M.A. (2013). Buses, cars, bicycles and walkers: the influence of the type of human transport on the flight responses of waterbirds. PloS one, 8(12), e82008.

Méndez, V., Gill, J.A., Alves, J.A., Burton, N.H., and Davies, R.G. (2018). Consequences of population change for local abundance and site occupancy of wintering waterbirds. Diversity and Distributions, 24(1), pp.24-35.

Marine Management Organisation (MMO) (2018). Record of Appropriate Assessment Regulation 63 of the Conservation of Habitats and Species Regulations 2017, Statutory Instrument 2017/1012. MLA/2016/00463.

Milsom, T. P., Ennis, D. C., Haskell, D. J., Langton, S. D., & McKay, H. V. (1998). Design of grassland feeding areas for waders during winter: the relative importance of sward, landscape factors and human disturbance. Biological Conservation, 84(2), 119-129.

Mohanty, P.K., Patra, S.K., Bramha, S., Seth, B., Pradhan, U., Behera, B., Mishra, P. and Panda, U.S. (2012). Impact of groins on beach morphology: a case study near Gopalpur Port, east coast of India. Journal of Coastal Research, 28(1), pp.132-142.

Moulton, V.D., Richardson, W.J., Williams, M.T. and Blackwell, S.B. (2003). Ringed seal densities and noise near an icebound artificial island with construction and drilling. Acoustics Research Letters Online, 4, p.112.

Mullner, A., Linsenmair, K.E. and Wikelski, M. (2004). Exposure to ecotourism reduces survival and effects stress response in hoatzin chicks (Opisthocomus hoazin). Biological Conservation, 118, pp.549-558.

Nacci, D. and Jackim, E. (1989). Using the DNA alkaline unwinding assay to detect DNA damage in laboratory and environmentally exposed cells and tissues. Marine Environmental Research, 28(1-4), pp.333-337.

Natural England. (2015). Site Improvement Plan Humber Estuary. Planning for the Future Improvement Programme for England's Natura 2000 Sites (IPENS).

Natural England (2017).Natural England Evidence Information Note EIN033: motorised and non-motorised land vehicles.

Natural England. (2020). Multi-Agency Geographic Information for the Countryside (MAGIC) Interactive Map. [Online] Available at:https://magic.defra.gov.uk/.

Natural England. (2021a). Natural England Conservation Advice for Marine Protected Areas: Humber Estuary SAC. [Online] Available at: [redacted] (accessed July 2021).

Natural England. (2021b). Natural England Conservation Advice for Marine Protected Areas: Humber Estuary SPA. [Online] Available at: [redacted] (accessed July 2021).

Natural England (2022). MAGIC website (https://magic.defra.gov.uk/MagicMap.aspx). Accessed February 2022.

Naylor, L. A., MacArthur, M., Hampshire, S., Bostock, K., Coombes, M. A., Hansom, J. D. and Folland, T. (2017). Rock armour for birds and their prey: ecological enhancement of coastal engineering. In Proceedings of the Institution of Civil Engineers-Maritime Engineering (Vol. 170, No. 2, pp. 67-82). Thomas Telford Ltd.

Navedo, J.G., and Herrera, A.G. (2012). Effects of recreational disturbance on tidal wetlands: supporting the importance of undisturbed roosting sites for waterbird conservation. Journal of Coastal Conservation, 16(3), pp.373-381.

NBN. (2021). NBN Atlas. [redacted] Accessed October 2021.

Nedelec, S.L., Campbell, J., Radford, A.N., Simpson, S.D. and Merchant, N.D. (2016). Particle motion: the missing link in underwater acoustic ecology. Methods in Ecology and Evolution, 7, pp.836-842.

Newell, R.C., Seiderer, J.L. and Hitchcock, D.R. (1998). The Impact of Dredging Works in Coastal Waters: A Review of Sensitivity to Disturbance and Subsequent Recovery of Biological Resources on the Seabed. Oceanography and Marine Biology: An Annual Review, 36, pp.127-78.

NMFS. (2021). Section 7 Consultation Guidance: Pile Driving Noise Calculator (Excel spreadsheet download). Available at: https://www.fisheries.noaa.gov/southeast/consultations/section-7-consultation-guidance (accessed November 2021).

NOAA. (2018). 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59, p.167.

NOAA. (2021). User Manual and User Spreadsheet Tool - 2018 Acoustic Technical Guidance. Available at: https://www.fisheries.noaa.gov/action/user-manual-optional-spreadsheet-tool-2018-acoustic-technical-guidance (accessed November 2021).

O'Brien, D.J., Whitehouse, R.J.S. and Cramp, A. (2000). The cyclic development of a macrotidal mudflat on varying timescales. Continental Shelf Research, 20(12-13), pp.1593-1619.

Parchure, T.M., McAnally, W.H. and Teeter, A.M. (2001). Wave-induced sediment resuspension near the shorelines of the Upper Mississippi River system (No. ENV Report 20).

Pardal-Souza, A.L., Dias, G.M., Jenkins, S.R., Ciotti, Á.M. and Christofoletti, R.A. (2017). Shading impacts by coastal infrastructure on biological communities from subtropical rocky shores. Journal of Applied Ecology, 54(3), pp.826-835.

Parnell, K.E., Soomere, T., Zaggia, L., Rodin, A., Lorenzetti, G., Rapaglia, J. and Scarpa, G.M. (2015). Ship-induced solitary Riemann waves of depression in Venice Lagoon. Physics Letters A, 379(6), pp.555-559.

Paterson , W D , Russell , D J F , Wu , G-M , McConnell , B , Currie , J I , McCafferty, D J & Thompson , D (2019) , ' Post-disturbance haulout behaviour of harbour seals ' , Aquatic Conservation: Marine and Freshwater Ecosystems , vol. 29, no. S1 , pp. 144-156 . [redacted]

Pearce, B. (2008). The Significance of Benthic Communities for Higher Levels of the Marine Food-Web at Aggregate Dredge Sites using the Ecosystem Approach. Marine Ecological Surveys Limited, 24a Monmouth Place, Bath, BA1 2AY. 70pp. ISBN 978-0-9506920-5-0.

Pearce, F., Peeler, E. and Stebbing, P. (2012). Modelling the Risk of the Introduction and Spread of Non-Indigenous Species in the UK and Ireland. Cefas Report.

Perry, F. (2016). [Sabella pavonina] with sponges and anemones on infralittoral mixed sediment. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, Plymouth: Marine Biological Association of the United Kingdom. [Online] Available at: [redacted](accessed December 2020).

Peterson, C. H. (1991). Intertidal Zonation of Marine Invertebrates in Sand and Mud. American Scientist, pp.236-249.

Pienkowski, M. W. (1983). Surface activity of some intertidal invertebrates in relation to temperature and the foraging behavior of their shorebird predators. Marine ecology progress series. Oldendorf, 11(2), 141-150.

Pineda, M.C., Strehlow, B., Sternel, M., Duckworth, A., Den Haan, J., Jones, R. and Webster, N.S. (2017). Effects of sediment smothering on the sponge holobiont with implications for dredging management. Scientific Reports, 7(1), pp.1-15.

Pirotta, E., Brookes, K. L., Graham, I. M., and Thompson, P. M. 2014. Variation in harbour porpoise activity in response to seismic survey noise. Biology Letters, 10: 5.

Popper, A.N., Hawkins, A.D., Fay, R., Mann, D., Bartol, S., Carlson, Th., Coombs, S., Ellison, W.T., Gentry, R., Halvorsen, M.B., Lokkeborg, S., Rogers, P., Southall, B.L., Zeddies, D.G. and Tavolga, W.N. (2014). Sound exposure guidelines for fishes and sea turtles: A technical report prepared by ANSI-Accredited standards committee S3/SC1 and registered with ANSI. Springer, ASA Press. ISBN 2196-1212. (e-book ISBN 978-2-219-06659-2).

Prumm, M., and Iglesias, G. (2016). Impacts of port development on estuarine morphodynamics: Ribadeo (Spain). Ocean & Coastal Management, 130, pp.58-72.

Radford, C.A., Montgomery, J.C., Caiger, P. and Higgs, D.M. (2012). Pressure and particle motion detection thresholds in fish: a re-examination of salient auditory cues in teleosts. Journal of Experimental Biology, 215(19), pp.3429-3435.

Rayment, W.J. (2002). Semi-permanent tube-building amphipods and polychaetes in sublittoral mud or muddy sand. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme, Plymouth: Marine Biological Association of the United Kingdom. [Online] Available at: [redacted]

Rees, B.C., Bruce, J.H. and White, G.T. (2005). Factors affecting the behavioural responses of whooper swans (Cygnus c. Cygnus) to various human activities. Biological Conservation, 121, pp.369-382.

Reine, K. and Clarke, D. (1998). Entrainment by Hydraulic Dredges–A Review of Potential Impacts. Technical Note DOER-E1. U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Reuscher, M. G., Montagna, P. A., & Sturdivant, S. K. (2019). Sampling techniques for the marine benthos. In Cochran, J. K., Bokuniewicz, H. J., & Yager, P. L. (2019). Encyclopedia of Ocean Sciences. Academic Press. Pages 752-764.

Roberts, L., Hardig, H.R., Voellmy, I., Bruintjes, R., Simpson, S.D., Radford, A.N., Breithaupt, T. and Elliott M. (2016). Exposure of benthic invertebrates to sediment vibration: From laboratory experiments to outdoor simulated pile-driving. Proc. Mtgs. Acoust. 27. [Online] Available at: [redacted]

Rogers, S.I., Millner, R.S. and Mead, T.A. (1998). The distribution and abundance of young fish on the east and south coast of England (1981 to 1997). Science Series, Technical Report, Cefas, Lowestoft, 108, p.130.

Rodgers, J.A., and Schwikert, S.T., (2002). Buffer-Zone Distances to Protect Foraging and Loafing Waterbirds from Disturbance by Personal Watercraft and Outboard-Powered Boats. Conservation Biology, 16(1), 216-224.

Ross, K and Liley, D, (2014). Humber Winter Bird Disturbance Study. Unpublished report for the Humber Management Scheme by Footprint Ecology.

RSPB. (2010). [redacted] Accessed November 2021.

RSPB. (2021). [redacted] Accessed October 2021.

Ruddock, M. and Whitfield, D.P. (2007). A Review of Disturbance Distances in Selected Bird Species. A report from Natural Research (Projects) Ltd to Scottish Natural Heritage.

Ruiz, G.G. and Carlton, J.T. (2003). Invasive Species – Vectors and Management Strategies. Island Press, Washington, Covelo, London.

Russell, D.J.F. (2016). Movements of grey seal that haul out on the UK coast of the southern North Sea. Report for the Department of Energy and Climate Change (OESEA-14-47).

Salmon and Trout Conservation (2017). The impact of excess fine sediment on invertebrates and fish in riverine systems. Literature Review.

Santos, T.M., Cabral, J.A., Lopes, R.J., Pardal, M., Marques, J.C. and Goss-Custard, J. (2005). Competition for feeding in waders: A case study in an estuary of south temperate Europe (Mondego, Portugal). Hydrobiologia. 544(1), pp.155–166.

Schaeffer, D.J. and Herricks, E.E. (1993). Biological monitors of pollution. In Handbook of Hazardous Materials (pp. 69-80). Academic Press.

Schoeman, R.P., Patterson-Abrolat, C. and Plön, S., (2020). A global review of vessel collisions with marine animals. Frontiers in Marine Science, 7, p.29

Schwemmer, P., Mendel, B., Sonntag, N., Dierschke, V., and Garthe, S. (2011). Effects of ship traffic on seabirds in offshore waters: implications for marine conservation and spatial planning. Ecological Applications 21(5), 1851-1860Seawatch Foundation. (2021). Eastern England Sightings 2021. [Online] Available at: [redacted] (accessed August 2021).

Smit, C.J. & Visser, G.J. (1993) . Effects of disturbance on shorebirds: a summary of existing knowledge from the Dutch Wadden Sea and Delta area. Wader Study Group Bull. 68: 6-19.

Soomere, T. (2006). Nonlinear ship wake waves as a model of rogue waves and a source of danger to the coastal environment: a review. Oceanologia, 48(S).

Soulsby, R.L., Hamm, L., Klopman, G., Myrhaug, D., Simons, R.R., Thomas, G.P. (1993). Wave–current interaction within and outside the bottom boundary layer. Coastal Engineering 21, 41–69.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr, C.R., Kastak, D., Miller, J.H., Nachigall, P.E., Richardson, W,.J., Thomas, J.A and Tyack, P.L. (2007). Marine mammal noise exposure criteria: initial scientific recommendations. Aquatic Mammals 33, pp.411–521.

Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P. and Tyack, P.L. (2019). Marine mammal noise exposure criteria: updated scientific recommendations for residual hearing effects. Aquatic Mammals, 45(2).

Special Committee on Seals (SCOS). (2017). Scientific Advice on Matters Related to the Management of Seal Populations: 2017. [Online] Available at: [redacted]

Special Committee on Seals (SCOS). (2022). Scientific Advice on Matters Related to the Management of Seal Populations: 2021.

Spiga, I., Caldwell, G.S. and Bruintjes, R. (2016). Influence of Pile Driving on the Clearance Rate of the Blue Mussel, Mytilus edulis (L.). Proc. Mtgs. Acoust. 27. [Online] Available at: [redacted]

Stelzenmuller, V., Ellis, J.R., and Rogers, S.I. (2010). Towards a Spatially Explicit Risk Assessment for Marine Management: Assessing the Vulnerability of Fish to Aggregate Extraction. Biological Conservation, 143(1), pp.230-238.

Stillman, R.A., West, A.D., Goss-Custard, J.D., McGrorty, S., Frost, N.J., Morrisey, D.J., Kenny, A.J. and Drewitt, A.L. (2005). Predicting site quality for shorebird communities: a case study on the Humber estuary, UK. Marine Ecological Progress Series, 305, pp.203–217.

Stillman, R.A., West, A.D., Caldow, R.W., and Durell, S.E.L.V. (2007). Predicting the effect of disturbance on coastal birds. Ibis, 149(1), pp.73-81.

Stillman, R.A., West, A.D., Clarke, R.T. and Liley, D. (2012). Solent Disturbance and Mitigation Project Phase II: Predicting the impact of human disturbance on overwintering birds in the Solent. Report to the Solent Forum.

Strong P and Morris SR. (2010). Grey seal (Halichoerus grypus) disturbance, ecotourism and the Pembrokeshire Marine Code around Ramsey Island. J. Ecotourism 9(2): 117–132.

Scottish Government. (2010). Habitats Regulations Appraisal of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Appropriate Assessment Information Review. Potential for Adverse Effects on Anadromous Fish and Freshwater Pearl Mussel Features. March 2011.

Takada, Y. (1999). Influence of shade and number of boulder layers on mobile organisms on a warm temperate boulder shore. Marine Ecology Progress Series, 189, pp.171-179.

Thrush, S.F., Hewitt, J.E., Parkes, S., Lohrer, A.M., Pilditch, C., Woodin, S.A., Wethey, D.S., Chiantore, M., Asnaghi, V., De Juan, S. and Kraan, C. (2014). Experimenting with ecosystem interaction networks in search of threshold potentials in real-world marine ecosystems. Ecology, 95(6), pp.1451-1457.

Tidau, S., and Briffa. M. (2016). Review on behavioural impacts of aquatic noise on crustaceans. Proc. Mtgs. Acoust. 27. [Online] Available at: [redacted]

Tillin, H.M., Houghton, A.J., Saunders, J.E. and Hull, S.C. (2011). Direct and Indirect Impacts of Marine Aggregate Dredging. Marine ALSF Science Monograph Series No. 1. MEPF 10/P144. (Edited by R. C. Newell & J. Measures). p.41.

Tillin, H.M. (2016). Oligochaetes in variable or reduced salinity infralittoral muddy sediment. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, Plymouth: Marine Biological Association of the United Kingdom. [Online] Available at: [redacted]

Tillin, H.M. and Rayment, W., (2016). Hediste diversicolor and Limecola balthica in littoral sandy mud. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 05-04-2022]. Available from: h[redacted]

Tillin, H.M., Tyler-Walters, H. and Garrard, S.L. (2019). Infralittoral mobile clean sand with sparse fauna. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, Plymouth: Marine Biological Association of the United Kingdom. [Online] Available at: [redacted]

Todd, V.L., Todd, I.B., Gardiner, J.C., Morrin, E.C., MacPherson, N.A., DiMarzio, N. A., and Thomsen, F. (2015). A review of impacts of marine dredging activities on marine mammals. ICES Journal of Marine Science, 72(2), pp.328-340.

Tolhurst, T.J., Chapman, M.G. and Murphy, R.J. (2020). The Effect of Shading and Nutrient Addition on the Microphytobenthos, Macrofauna, and Biogeochemical Properties of Intertidal Flat Sediments. Frontiers in Marine Science, 7, p.419.

Thompson PM, Brookes KL, Graham IM, Barton TS, Needham K, Bradbury G, Merchant ND. (2013) Short-term disturbance by a commercial two-dimensional seismic survey does not lead to long-term displacement of harbour porpoises. Proc R Soc B 280: 20132001. [redacted]

Thomsen, F., McCully, S.R., Weiss, L.R., Wood, D.T., Warr, K.J., Barry, J. and Law, R.J. (2011). Cetacean stock assessments in relation to exploration and production industry activity and other human pressures: review and data needs. Aquatic Mammals, 37(1), pp.1-93.

Tougaard, J., Carstensen, J., Teilmann, J., Skov, H., and Rasmussen, P. (2009). Pile driving zone of responsiveness extends beyond 20 km for harbor porpoises (Phocoena (L.)). The Journal of the Acoustical Society of America, 126, pp.11–14.
Tweedley, J.R., Hallett, C.S., Warwick, R.M., Clarke, K.R. and Potter, I.C. (2015). The hypoxia that developed in a microtidal estuary following an extreme storm produced dramatic changes in the benthos. Marine and Freshwater Research, 67(3), pp.327-341.

Tyler-Walters, H., Tillin, H.M., d'Avack, E.A.S., Perry, F., Stamp, T. (2018). Marine Evidence-based Sensitivity Assessment (MarESA) – A Guide. Marine Life Information Network (MarLIN). Marine Biological Association of the UK, Plymouth, p. 91. [Online] Available at: [redacted] (accessed December 2020).

Tyler-Walters, H. & Garrard, S.L., 2019. Arenicola marina in infralittoral fine sand or muddy sand. In Tyler-Walters H. and Hiscock K. Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 10-12-2021]. Available from: h[redacted]

Uncles, R. J., Stephens, J. A., & Law, D. J. (2006). Turbidity maximum in the macrotidal, highly turbid Humber Estuary, UK: Flocs, fluid mud, stationary suspensions and tidal bores. Estuarine, Coastal and Shelf Science, 67(1-2), 30-52.

UK Marine SACs Project. (2001). Environmental impacts of a ship's wash. [Online] Available
at [redacted]

Van Colen, C., Thrush, S.F., Parkes, S., Harris, R., Woodin, S.A., Wethey, D.S., Pilditch, C.A., Hewitt, J.E., Lohrer, A.M. and Vincx, M. (2015). Bottom–up and top–down mechanisms indirectly mediate interactions between benthic biotic ecosystem components. Journal of Sea Research, 98, pp.42-48.

Van Dijk, W.M., Cox, J.R., Leuven, J.R.F.W., Cleveringa, J., Taal, M., Hiatt, M.R., Sonke, W., Verbeek, K., Speckmann, B. and Kleinhans, M.G. (2019). The vulnerability of tidal flats and multi-channel to dredging and disposal, EarthArxiv.

Verney, R., Deloffre, J., Brun-Cottan, J.C. and Lafite, R. (2007). The effect of wave-induced turbulence on intertidal mudflats: Impact of boat traffic and wind. Continental Shelf Research, 27(5), pp.594-612.

Waggitt, J.J., Evans, P.G.H., Andrade, J., Banks, A.N, Boisseau, O., Bolton, M., Bradbury, G., et al. (2020). Distribution maps of cetacean and seabird populations in the North-East Atlantic. Journal of Applied Ecology, 57: 253-269. doi: 10.1111/1365-2664.13525.

Walters, K., Kosciuch, K. & Jones, J. (2014). Can the effect of tall structures on birds be isolated from other aspects of development? Wildlife Society Bulletin DOI:10.1002/wsb.394.

Waugh, A., Elliott, M. and Franco, A. (2019). Debunking paradigms in estuarine fish species richness. Marine Ecology Progress Series, 613, pp.125-138.

Webb, J. F., Popper, A. N. and Fay, R. R. (2008). Fish Bioacoustics. New York, NY: Springer.

Wenger, A.S., Harvey, E., Wilson, S., Rawson, C., Newman, S.J., Clarke, D., Saunders, B.J., Browne, N., Travers, M.J., Mcilwain, J.L. and Erftemeijer, P.L. (2017). A critical analysis of the direct effects of dredging on fish. Fish and Fisheries, 18(5), pp.967-985.

Williams, G.A. (1994). The relationship between shade and molluscan grazing in structuring communities on a moderately-exposed tropical rocky shore. Journal of Experimental Marine Biology and Ecology, 178(1), pp.79-95.

Wilson, S.C. (2014). The impact of human disturbance at seal haul-outs. A literature review for the Seal Conservation Society.

Wilson, S. (2009). Estuarine Bird Monitoring (05 Dec 2008-19 Jan 2009) - TERRC Facility. Prepared for Hartlepool Borough Council.

World Organization of Dredging Associations (WODA). (2013). Technical Guidance on: Underwater Sound in Relation to Dredging.

Woodward, I.D., Calbrade, N.A and Holt., C.A. (2014). Humber Estuary Bird Decline Investigation 2014. BTO Research Report No. 668. Report of work carried out by The British Trust for Ornithology under contract to Natural England.

Woodward, I.D., Calbrade, N.A and Austin G.E. (2018). Analysis of Wetland Bird Survey (WeBS) Data for The Humber Estuary SSSI, SAC, SPA and Ramsar site: Third appraisal – sector-level trends to winter 2016/17.

Woodward, I.D., Frost, T.M., Hammond, M.J., and Austin, G.E. (2019a). Wetland Bird Survey Alerts 2016/2017: Changes in numbers of wintering waterbirds in the Constituent Countries of the United Kingdom, Special Protection Areas (SPAs), Sites of Special Scientific Interest (SSSIs) and Areas of Special Scientific interest (ASSIs). BTO Research Report 721. BTO, Thetford.

Woodward, I., Thaxter, C.B., Owen, E. & Cook, A.S.C.P (2019b). Desk-based revision of seabird foraging ranges used for HRA screening, Report of work carried out by the British Trust for Ornithology on behalf of NIRAS and The Crown Estate, ISBN 978-1-912642-12-0

Wright, M.D., Goodman, P., and Cameron, T.C. (2013). Exploring behavioural responses of shorebirds to impulsive noise. Wildfowl, 60(60), pp.150-167.

Wright, L.J., Mendez, V., and Burton, N.H. (2014). Review of knowledge regarding the effect of major estuarine developments on bird populations with reference to proposals for an airport in the Thames Estuary. British Trust for Ornithology.

Xodus. (2012). Grimsby River Terminal Construction Pile Noise Monitoring and Bird Behaviour Observations. Associated British Ports.

Zaggia, L., Lorenzetti, G., Manfé, G., Scarpa, G.M., Molinaroli, E., Parnell, K.E., Rapaglia, J.P., Gionta, M. and Soomere, T. (2017). Fast shoreline erosion induced by ship wakes in a coastal lagoon: Field evidence and remote sensing analysis. PloS one, 12(10), p.e0187210.

9.13 Abbreviations/Acronyms

AA	Appropriate Assessment
ABB	ABB Power Generation Ltd
ABP	Associated British Ports
AL	Action Level
AMEP	Able Marine Energy Park
BAP	Biodiversity Action Plan
BEIS	Department for Business, Energy and Industrial Strategy
BNG	Biodiversity Net Gain
BTO	British Trust for Ornithology
CEDA	Central Dredging Association
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CEMP	Construction Environmental Management Plan
CIEEM	Chartered Institute of Ecology and Environmental Management
CoCP	Code of Construction Practice
CoSA	Conservation of Seals Act
COVID	Coronavirus
CRoW	Countryside and Rights of Way Act
cSAC	Candidate Special Areas of Conservation
CSIP	Cetacean Strandings Investigation Programme
D	Diadromous species
dB	Decibel
dBA	A-weighted decibel
DCO	Development Consent Order
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
EC	European Commission
EcIA	Ecological Impact Assessment
EEC	European Economic Community
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	European Marine Site
ERM	ERM Group
ES	Environmental Statement
ES	Estuarine resident Species
EU	European Union
F	Freshwater species
FID	Flight Initiation Distance,
FOCI	Feature of Conservation Importance
GB	Great Britain
HEEs	High Energy Events
HF	High-Frequency
HGVs	Heavy Goods Vehicle

HMWB	Heavily Modified Water Body
HRA	Habitats Regulations Assessment
ID	Identity
IECS	The Institute of Estuarine & Coastal Studies
IEERT	Immingham Eastern Roll-on Roll-off Terminal
IEMA	Institute of Environmental Management and Assessment
IERRT	Immingham Eastern Ro-Ro Terminal
IMO	International Maritime Organization
INNS	Invasive Non-native Species
IOH	Immingham Outer Harbour
IOT	Immingham Oil Terminal
IPENS	Improvement Programme for England's Natura 2000 Sites
JCP	Joint Cetacean Protocol
JNCC	In-combination Climate Change Impacts
LAeq	Equivalent Continuous Sound Pressure Level,
LAmax F	Maximum 'A'-weighted Sound Pressure Level (Fast Time Weighed)
LERC	Lincolnshire Ecological Records Centre
LGS	Local Geological Sites
Lmax.	Maximum 'A'-weighted Sound Pressure Level
LNR	Local Nature Reserve
LSE	Likely Significant Effect
LWS	Local Wildlife Site
MAGIC	Multi-Agency Geographic Information for the Countryside
MALSF	Marine Aggregate Levy Sustainability Fund
MarESA	Marine Evidence based Sensitivity Assessment
MCAA	Marine and Coastal Access Act
MCCIP	Marine Climate Change Impact Partnership
MCZ	Marine Conservation Zone
MHWS	Mean high Water Springs
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Springs
MM	Marine Migrant species
MMO	Marine Management Organisation
MP	Mean Peak
MPA	Marine Protected Area
MPS	Marine Policy Statement
MS	Marine Straggler species
MW	Megawatt
NBN	National Biodiversity Network
NELC	North East Lincolnshire Council
NERC	Natural Environment and Rural Communities
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPSfP	National Policy Statement for Ports

NSIP	Nationally Significant Infrastructure Projects
O&M	Operation and Maintenance
PAH	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyl
PEA	Preliminary Ecological Appraisal
PEIR	Preliminary Environmental Information Report
PIANC	The World Association for Waterborne Transport Infrastructure
PINS	Planning Inspectorate
PSA	Particle Size Analysis
pSPA	Potential Special Protection Areas
PTS	Permanent Threshold Shifts
PW	Phocid Pinniped
Ramsar	Wetlands of international importance, designated under The Convention on Wetlands (Ramsar, Iran, 1971)
REC	Regional Environmental Characterisation
RMS	Root Mean Square
Ro-Ro	Roll On-Roll Off
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SCANS	Small Cetaceans in European Atlantic Waters and the North Sea
SCOS	Special Committee on Seals
SEL	Sound Exposure Levels
SL	Source Level
SMRU	Sea Mammal Research Unit
SPA	Special Protection Area
SPL	Sound Pressure Levels
SSC	Suspended Sediment Concentrations
SSSI	Site of Special Scientific Interest
SSSI	Sites of Special Scientific Interest
STST	Selective Tidal Stream Transport’
TBT	Tributyltin
TOC	Total Organic Carbon
TPH	Where Total Petroleum Hydrocarbons
TraC	Transitional and Coastal Waters
TSHD	Trailer Suction Hopper Dredger
TTS	Temporary Threshold Shift
UK	United Kingdom
WCA	Wildlife and Countryside Act
WeBS	Wetland Bird Survey
WFD	Water Framework Directive
WODA	World Organization of Dredging Associations

Cardinal points/directions are used unless otherwise stated.
SI units are used unless otherwise stated.

9.14 Glossary

Term	Definition
Baseline conditions	Existing conditions and past trends associated with the environment in which a proposed activity may take place
Bathymetry	The measurement of depth of the water
Beam trawls	Fishing net towed along the seafloor to target fish living in or on sand and muddy seabed environments
Benthic habitats	Habitats associated with the bottom of a body of water
Biomass	The weight of living organisms
Coastal lagoon	A shallow body of water separated from a larger body of water by a narrow landform such as sandbars or barrier islands
Cumulative effects	Combined effects of multiple developments or the combined effect of individual impacts (e.g. where different project elements in different locations have a cumulative impact on a particular feature)
Day grab	Two stainless bucket sections which are mounted within a stainless steel frame to collect benthic sediment samples
Demersal fish	Fish that live and feed on or near the bottom of water bodies
Ecoregion	Relatively large units of land or water containing a distinct assemblage of natural communities sharing a large majority of species, dynamics, and environmental conditions
European Marine Site	Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) that are covered by tidal waters and protect some of our most important marine and coastal habitats and species of European importance.
Fluvial	Relating to stream or river processes
Fyke nets	A fish trap consisting of a cylindrical or cone-shaped net mounted on rings or rigid structures. t has wings or leaders which guide the fish towards the entrance of the bags.
Hamon grab	Comprises of a stainless steel box shaped sampling scoop mounted in a triangular frame to collect benthic (generally coarse) sediment samples
Hazard	A substance, operation or piece of equipment which has the potential to cause harm to people or the environment
Infaunal	Aquatic animals that live in the substrate at the bottom of a body of water
Interglacial	Warmer period between two glaciations
Intertidal	The area between high and low tide also known as the foreshore or seashore
Invertebrate	Animals which lack a vertebral column / backbone
Nursery ground	Habitats that enhance the growth and survival of juveniles

Term	Definition
Otter trawls	A large fishing net that is dragged behind a vessel mainly used to catch demersal fish living above the seafloor
Pelagic	The water column of coasts, open oceans and lakes
Ramsar	Wetlands of international importance designated under the Ramsar Convention
Resistance	Resistance characteristics indicate whether a receptor can absorb disturbance or stress without changing character
Risk	The likelihood of a specified level of harm occurring within a specified period of time
Salicornia	A genus of flowering plants that grow in salt marshes, on beaches, and among mangroves.
Seine netting	A fishing net that hangs vertically in the water (with its bottom edge held down by weights and its top edge buoyed by floats) used to haul or herd fish
Site of Special Scientific Interest	An area of land which is of special interest for its flora, fauna, geological, geomorphological or physiographical features
Special Area of Conservation	A designated area protecting one or more habitats or species listed in the Habitats Directive
Special Area of Conservation	A designated area protecting habitats and species identified in Annexes I and II of the Habitats Directive
Special Protection Area	A designated area protecting one or more rare, threatened or vulnerable bird species listed in Annex I of the Birds Directive
Subtidal	The area where the seabed is below the low tide water mark
Telemetry tags	Tags which are attached to an animal to determine its location through detection of a signal from a transmitter
Turbidity	Turbidity is the measure of relative clarity of a liquid and is a measurement of the amount of light that is scattered by the material in the water
Van Veen grab	A clamshell bucket made of stainless steel to collect benthic sediment samples
Waterbirds	Birds that live on or around water

Contact Us

ABPmer

Quayside Suite,
Medina Chambers
Town Quay, Southampton
SO14 2AQ

T +44 (0) 23 8071 1840
F +44 (0) 23 8071 1841
E enquiries@abpmer.co.uk

[redacted]