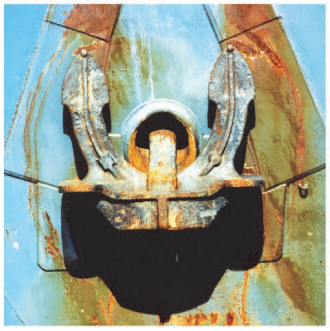
Associated British Ports

Immingham Eastern Ro-Ro Terminal

Preliminary Environmental Information
Chapter 9: Nature Conservation and Marine Ecology

January 2022

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Authors

ABPmer

ABPmer
Quayside Suite, Medina Chambers, Town Quay, Southampton, Hampshire SO14 2AQ
T: +44 (0) 2380 711844 W: http://www.abpmer.co.uk/

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9.1 Introduction

9.1.1 This chapter provides a preliminary assessment of the potential significant effects of the proposed Immingham Eastern Ro-Ro Terminal (IERRT) on nature conservation and marine ecology. This chapter has been prepared by ABPmer.

9.1.2 The preliminary assessment has been undertaken on the basis of a common understanding of the proposed development based on current scheme assumptions, as detailed in Chapter 2 and 3 of this Preliminary Environmental Information Report (PEIR).

9.1.3 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.

9.1.4 There are no classified commercial shellfish (bivalve) beds in the Humber Estuary (Cefas, 2021) and the areas around the proposed IERRT and possible disposal sites (if no beneficial alternative is identified) do not support other commercial shellfisheries (such as crab/lobsters using creels or the collection of whelks). On this basis, commercial shellfisheries have, therefore, 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 PEIR assist in describing the existing environment (baseline). 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 shows 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 is 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 Sector B during different months is provided in Figure 9.9 with the distribution of coastal waterbirds within Sector B shown in Figure 9.10.

9.1.6 The Physical Processes assessment (Chapter 7), Water and Sediment Quality assessment (Chapter 8) and underwater noise assessment (Appendix 9.2, Volume 3 of the PEIR) 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 will inform the Water Framework Directive (WFD) Assessment and also the Habitats Regulations Assessment (HRA) which will be prepared and included in the Environmental Statement (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 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 area and possible disposal sites (if no beneficial alternative is identified) 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 has been collected and analysed by ABPmer for over 20 years. This vast knowledge and experience has been used to provide a robust baseline description of the area as well as an early understanding of potential impacts. 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);
- 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 https://designatedsites.naturalengland.org.uk/.

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 3.5 km from the proposed development with data available up to 2017 for Foulholme Sands and 2019 for Burcom (Environment Agency, 2021b);
- 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;
- 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 (Waggit *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, 2021);
- 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. During each survey, either five counts (October and March) or four counts (November to February) are undertaken every two hours after high water[1]. The surveys started in winter 1997/98 and have been ongoing annually since then. The most recent 5-years of data (2016/17 to 2020/21) has been analysed;
- 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. The most recent 5-years of data available from the British Trust for Ornithology (BTO) (2015/16 to 2019/20) has been analysed. In addition, estuary wide WeBS data for the Humber Estuary for the same period will also be reviewed to provide contextual information (Frost *et al*., 2021);
- 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*., 2019). 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).

9.3.2 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 are shown in Figure 9.2.

[1] The 2021/22 survey season started in August rather than October as per previous years in order to better understand passage numbers. The initial results from this season (i.e. August and September) have also been presented.

9.3.3 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.

Determining significance of effects

9.3.4 To facilitate the impact assessment process and ensure consistency in the terminology of significance, a standard assessment methodology has been applied. 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 (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).

9.3.5 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.

9.3.6 The environmental issues are divided into distinct 'receiving environments' or 'receptors'. The effect of the proposed development on each of these have 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. In accordance with CIEEM (2018), an impact is defined as an action resulting in changes to an ecological features (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

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

9.3.8 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.

9.3.9 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.

9.3.10 Once a magnitude has been assessed, this should be 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

9.3.11 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.

9.3.12 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;
- Medium: 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.

9.3.13 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.

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.
Fish	Fish species in the study area are considered to have a **low** sensitivity to marine habitat change on the scale predicted (due to the high mobility of the species). These species are considered to have a **low to moderate sensitivity** to water quality and underwater noise (depending on the species).
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 (due to the high mobility of the species). These species are considered to have a **moderate** sensitivity to the anticipated level of underwater noise generated by the project.
Coastal waterbirds	Coastal waterbirds are generally considered to have a **low** to **moderate** sensitivity to marine habitat change / loss and changes in water quality on the scale predicted (due to the high mobility of the species). These species are considered to have a **low to moderate** sensitivity to noise and visual disturbance (depending on the species) on the scale predicted.

Receptor importance

9.3.14 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.

9.3.15 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).

9.3.16 The importance of each ecological receptor has been determined, at this preliminary stage, based on the following criteria:

- Low: The receptor is not protected or designated and is considered to be of low to moderate biodiversity or supporting value;

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

9.3.17 The importance of a receptor has also been considered at this preliminary stage 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).

9.3.18 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. Preliminary 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), 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. If disposal at sea proves unavoidable, the sites currently identified are considered to be of **medium** importance due to the 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. Other subtidal habitats near to the proposed development are currently considered to be of **low** importance due to the generally low ecological value of the habitat and given that the habitat is a not characteristic of any of the qualifying features of overlapping designated sites.
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 medium importance. Other species such as diadromous migratory species (European eel, Atlantic salmon, sea trout, sea lamprey, river lamprey, twaite shad, allis shad, European smelt), and) are considered to be of high importance.

Receptor	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

9.3.19 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.

9.3.20 In summary, to assess the significance of effects at this stage in the assessment process, 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.

9.3.21 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. So, a significant negative effect on a feature of importance at one level would be likely to generate the need for development control mechanisms, such as Development Consent Order (DCO) Protective Provisions or Requirements.

9.3.22 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.

9.3.23 To ensure transparency in the impact assessment, even in relation to a PEIR, 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.

9.3.24 Following the preliminary 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 preliminary conclusions section of this chapter

(Section 9.11). Confidence was assessed on a scale incorporating three values: low, medium and high.

9.3.25 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 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

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

9.3.27 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

9.3.28 Table 9.5 has then been used to score, at this preliminary stage in the process, 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

9.3.29 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)

9.3.30 Impacts that are found to be significant, albeit at this preliminary stage 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.

9.3.31 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 account of in the initial impact assessment.

9.3.32 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;
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.

9.3.33 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 An initial consultation as to whether there are likely to be any marine ecology effects created by the project has to date been undertaken with the Environment Agency. In addition, the responses received as a result of the scoping process have also been taken into account so as to inform the preliminary assessment.

9.4.2 The outcome of the consultation and formal scoping process that has been undertaken to date, along with how it has influenced the nature conservation and marine ecology assessment, is presented in Table 9.7.

Table 9.7. Summary of consultation to date

Consultee	Reference, Date	Summary of Response	How comments have been addressed in this chapter
Planning Inspectorate (PINS) Marine Management Organisation (MMO) Natural England (NE)	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 out of the assessment with a rationale for this provided in the PEIR.
PINS Natural England	Scoping Opinion, October 2021 Table ID 4.3.3 Appendix 2 Natural England response	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 with the relevant consultation bodies and the absence of an LSE.	This pathway has been scoped out of the assessment with a rationale for this provided in the PEIR.

Consultee	Reference, Date	Summary of Response	How comments have been addressed in this chapter
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 PEIR.
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 protections are given by law and policy for Features of Conservation Importance.	The Holderness Inshore Marine Conservation Zone (MCZ) is the nearest MCZ to the IERRT (located approximately 20 km away). This is considered to beyond the zone of potential effects of the proposed development. Consequently, reference to Feature of Conservation Importance (FOCI) has been removed from the baseline section for the PEIR.

Consultee	Reference, Date	Summary of Response	How comments have been addressed in this chapter
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 NE, 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 NE.	It is noted that the 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 or mortality would also be expected to be negligible. The Lagoons SSSI (located approximately 20 km from the Proposed Development) and Greater Wash Special Protection Area (SPA)

Consultee	Reference, Date	Summary of Response	How comments have been addressed in this chapter
			(located approximately 70 km from the proposed development) are considered to have limited functional links to the Proposed Development as coastal waterbirds typically show site fidelity to relatively localised areas with potential effects on these sites considered to be negligible.
PINS Natural England	Scoping Opinion, October 2021 Table ID 4.3.9 Appendix 2 Natural England response	NE 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 justification (supported by evidence) that no LSE would arise as a result of this effect pathway.	This pathway has been considered in the assessment.
PINS Natural England	Scoping Opinion, October 2021 Table ID 4.3.10 Appendix 2 Natural England response	NE 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.
PINS MMO	Scoping Opinion, October 2021 Table ID 4.3.11	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	Potential disturbance to coastal waterbirds resulting from noise and visual stimuli in operation (including vessel movements) has been considered in the

Consultee	Reference, Date	Summary of Response	How comments have been addressed in this chapter
	Appendix 2 MMO response	evidence of agreement to this approach from NE and the MMO.	assessment. Operational underwater noise effects have been scoped out with a rationale provided in the PEIR.
PINS MMO	Scoping Opinion, October 2021 Table ID 4.3.12 Appendix 2 MMO response	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 why the approach is considered to be robust.	Noted.
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 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 therefore 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.

Consultee	Reference, Date	Summary of Response	How comments have been addressed in this chapter
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 NE 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, 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.	The IOH surveys which overlap with the proposed development cover low and high tide period. The 2021/22 survey season started in August rather than October (as per previous years) in order to better understand passage numbers. The initial results from this season (i.e. August and September 2021) have also been presented.
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 NE 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 have not to date been providing a Discretionary Advice Service during this period and so this has not been possible.
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 metric.	This is still under consideration. Terrestrial habitat may need to be created and the loss of any intertidal habitat associated with the marine works is being considered separately as part of the requirements under the Habitats Regulations.
Environment Agency	Scoping Opinion, October 2021 Appendix 2 Environment Agency response Pre-application meeting, 29 November 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 provides further information on the specific habitat and species interest features of the Humber Estuary and Section 9.8 includes a preliminary consideration of the effects of the proposed development on these features.

Consultee	Reference, Date	Summary of Response	How comments have been addressed in this chapter
			A separate HRA will be submitted as part of the DCO application.
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 Appendix 2 MMO response	The MMO would expect the effects of changes to Suspended Sediment Concentrations (SSC) and sediment deposition on benthic ecology receptors to be assessed in the ES.	These pathways have been considered in the assessment.
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 Chapter 20 of the PEIR and will be included in the 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	This is described in Section 9.6.

Consultee	Reference, Date	Summary of Response	How comments have been addressed in this chapter
		(e.g., gear selectivity and the timing of surveys) are acknowledged.	
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 consideration of impacts through the EIA process.	A HRA will be undertaken as part of the ES.
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 – albeit at a preliminary stage.
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

Consultee	Reference, Date	Summary of Response	How comments have been addressed in this chapter
			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 will consider potential effects on local sites.
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 will be included in the final assessment.
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 will be considered within the final assessment.
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.

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	In June Government announced their response to the Dasgupta review which introduced amendments to the Environment Bill. A key feature of this 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.	Noted.
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 will be reviewed for the in-combination assessment within the HRA.
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 Humber Estuary designation have been dealt with here.	A HRA will be undertaken as part of the ES.

Consultee	Reference, Date	Summary of Response	How comments have been addressed in this chapter
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. An assessment of cumulative effects will be provided in the ES; the approach to the cumulative effects assessment is explained further in Chapter 20.

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 Legislative and Consenting Framework (Chapter 5). This will be kept under review as the assessment progresses.

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 (Amendment) (EU Exit) Regulations 2019, known as the Habitats Regulations[2].

9.5.5 The 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 the

[2] 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).

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 Directive. 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 IERRT falls within these designated sites, ABP is of the view that the project will trigger the requirement for a HRA.

9.5.8 Information to support the Competent Authority's assessment of the proposed development against the requirements of the Habitats Regulations will be provided in the DCO application. This will be included as an appendix to the ES, drawing 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 WFD (2000/60/EEC)[3] 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 will be prepared to support the DCO application. This will assess the potential impacts of the proposed development on biological, chemical and physical elements of the relevant WFD water bodies and will determine whether the proposed development complies with the objectives of the WFD. This 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 will be included in an appendix to the ES and will

3 European Union (2000) Directive 2000/60/EEC.

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.

draw on information provided both in the 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 a MCZ Assessment is not considered to be required.

The Wildlife and Countryside Act (WCA)

9.5.15 The WCA 1981 is the principal mechanism for the legislative protection of wildlife in Great Britain.

9.5.16 The Act is the means by which the Bern Convention, the Birds Directive (79/409/EEC) and the Natural Habitats and Wild Fauna and Flora Directive (92/43/FFC) are implemented in Great Britain.

9.5.17 The Act 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 (CRoW)

9.5.18 The CRoW 2000 applies to England and Wales only. Part III of the Act deals specifically with wildlife protection and nature conservation.

9.5.19 The 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 Act amends the SSSI provisions of the Wildlife and Countryside Act 1981, 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. The NERC Act 2006.

9.5.20 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.

National policy

National Policy Statement for Ports

9.5.21 The National Policy Statement for Ports (NPSfP) (2012) provides the framework for decisions on proposals for new port developments (DfT, 2012). 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 (DfT, 2012).

9.5.22 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 (DfT, 2012).

9.5.23 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 (DfT, 2012).

UK Marine Policy Statement (MPS)

9.5.24 The Marine Policy Statement (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..."*

9.5.25 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 a MCZ. This would also include the obligations in relevant legislation relating to SSSIs and sites designated under the Wild Birds and Habitats Directives (Defra, 2011).

East Inshore and East Offshore Marine Plans

9.5.26 The East Inshore and East Offshore Marine Plans, which are collectively referred to as 'the East Marine Plans', were formally adopted on 2 April 2014 (Defra, 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.

9.5.27 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: Preliminary information on the cumulative and in-combination effects assessment for the proposed development are included in Chapter 20 of the PEIR;
- 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 including on habitats and species that are protected or of conservation concern in the East marine plans and adjacent areas (marine, terrestrial): Further details on the preliminary 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 account of in strategic level measures and assessments, with due regard given to any current agreed advice on an ecologically coherent network: Further information will be provided in an HRA which will be included as an appendix to the ES. 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 put in place appropriate measures to avoid or minimise significant adverse impacts on the marine area that would 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

9.5.28 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*."

9.5.29 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 Preliminary description of the existing environment

Nature conservation sites and protected species

Designated sites

9.6.1 The Immingham Eastern RoRo Terminal 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) 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 9.7 and Table 9.8 respectively.

Table 9.7. 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 wildfowl assemblage.	

Source: JNCC (2022b)

Table 9.8. 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 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.

9.6.5 The Holderness Inshore MCZ is the nearest MCZ to the Immingham Eastern RoRo Terminal (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.

9.6.6 The nearest Local Nature Reserve (LNR) is Cleethorpes Sands LNR (located approximately 13 km south east of the Immingham Eastern RoRo Terminal) which supports a variety of intertidal and coastal habitats.

Protected species

9.6.7 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*;
- Cetacean (whale and dolphin) species; and
- All bird species.

9.6.8 Marine species are also protected from being killed, injured or disturbed both inside and outside designated sites under the provisions of the European 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).

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

9.6.10 All naturally occurring wild bird species, their eggs, nests and habitats are strictly protected under the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019.

9.6.11 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 2006 (England). 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*). Habitats of principle importance of relevance to the Humber Estuary include intertidal mudflats and coastal saltmarsh.

9.6.12 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 gives powers to statutory bodies to implement measures for the recovery of European eel stocks including improving access, habitat quality and fishing pressure.

Benthic habitats and species

Humber Estuary overview

9.6.13 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, 2015).

9.6.14 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, 2015).

9.6.15 The subtidal area of the Estuary is approximately 16,800 ha in extent (English Nature, 2003). The subtidal environment of the Humber 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).

9.6.16 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

9.6.17 In order to characterise the benthic communities present in the vicinity of the proposed development (and associated dredge disposal sites should they be required), 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 RoRo Terminal intertidal samples**: Ten stations within and near to the proposed development footprint (Figure 9.2);
- **Immingham Eastern RoRo Terminal intertidal 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).

9.6.18 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.

9.6.19 The results of these project specific benthic surveys are summarised below and in Table 9.8 to 9.10 with the methods and results described in more detail in Appendix 9.1.

Immingham Eastern RoRo Terminal intertidal samples

9.6.20 The sediment in samples collected in this area consisted predominantly of sandy mud (Table 9.8). 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 9.8).

9.6.21 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 9.8).

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

9.6.23 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).

9.6.24 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. 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 9.9. The benthic prey recorded in the surveys were typically small size classes that are consumed by both smaller and larger wading bird species.

Table 9.8. 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 9.9. Size classes of key bird prey species

Species group	Species	Size Class	Abundance (per sample)	% (per sample)
Polychaetes	*Eteone longa*	<25 mm	14	100
		>25 mm	0	0
	Hediste diversicolor	<25 mm	113	77
		25-50 mm	34	23
	Nephtys spp	<25 mm	3	100
		>25 mm	0	0
	Pygospio elegans	<25 mm	68	100
		>25 mm	0	0
	Streblospio shrubsolii	<25 mm	12	100
		>25 mm	0	0
	Tharyx	<25 mm	3	100
		>25 mm	0	0
	Manayunkia aestuarina	<25 mm	22	100
		>25 mm	0	0
Crustacean	*Corophium volutator*	<3 mm	142	65
		>3 mm	75	35
Gastropod	*Peringia ulvae*	<3 mm	136	99
		3-5 mm	1	1
Bivalves	*Limecola balthica*	<9 mm	117	98
		9-15 mm	2	2
	Abra tenuis	<5 mm	51	100
		>5 mm	0	0
	Scrobicularia plana	20-25 mm	2	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 RoRo Terminal subtidal samples

9.6.25 The sediment from samples collected from the area of the proposed Immingham Eastern RoRo Terminal consisted of mud and sandy mud). The TOC in the samples ranged between approximately 3 % and 13 % (Table 9.10). 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.

9.6.26 The faunal samples were predominantly characterised by nemotodes, 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.

9.6.27 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

9.6.28 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 9.10). 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.).

9.6.29 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).

9.6.30 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

9.6.31 The sediment in samples collected in this area consisted predominately of sand with TOC between approximately<1 and 3 % at all stations (Table 9.10).

9.6.32 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.

9.6.33 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.

9.6.34 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 9.10. 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 RoRo 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)
	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)

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 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)
	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)

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)
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)
	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)

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)
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

9.6.35 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).

9.6.36 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).

9.6.37 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 the estuary (Waugh *et al.*, 2019).

9.6.38 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) has been used in help summarise the life history and ecology of fish species occurring in the Humber Estuary:

- 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 number. 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.

9.6.39 Table 9.11 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 9.11. 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

Ecological guild	Species name	Common name	Ecological guild	Species name	Common name
	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
	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

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

Source: Environment Agency, 2013.

Marine migrant species (MM)

9.6.40 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 9.12. Other gadoids commonly occurring include pouting *Trisopterus luscus* and pollack *Pollachius pollachius*.

9.6.41 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 9.12 and Figure 9.4). In addition, dab *Limanda limanda* and turbot *Scophthalmus maximus* are also recorded.

9.6.42 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). 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 9.12.

Table 9.12. 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 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 lives 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.

Species	Ecology
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).
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

9.6.43 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.

9.6.44 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).

9.6.45 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

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

9.6.47 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

9.6.48 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.

9.6.49 Further information on the ecology and migration of these species is provided in Table 9.13.

Table 9.13. 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 (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.
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 the spring and summer. The

Species	Ecology
	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, herring, salmon, 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 is 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.
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 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

Species	Ecology
	recorded from the upper reaches of the Ouse with brown/sea trout are widespread in the upper reaches of the Humber catchment. In the Humber Estuary, most Atlantic salmon and sea trout have been recorded in the spring months and have been of smolt size.

Sources, Environment Agency, 2013; Maitland and Hatton-Ellis, 2003 Maitland, 2003

Summary

9.6.50 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

9.6.51 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. The Foulholme Sands surveys were undertaken twice a year in the spring and autumn with the Burcom surveys annually in the early winter. These monitoring sites are located approximately 3.5 km from the proposed development and are shown in Figure 9.4. Data was available up to 2017 for Foulholme Sands and up to 2019 for Burcom (Environment Agency, 2021b).

Table 9.14. 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

Species	Burcom Otter Trawl*	Foulhome Sands Beam Trawl**	Foulhome Sands Seine Net***
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			

9.6.52 In summary, the most abundant species recorded in the surveys summarised in Table 9.14 were sand gobies, the flatfish species plaice and Dover sole, the pelagic species herring and the gadoids whiting and cod. Other 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.

9.6.53 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 monitoring has used a variety of techniques to target different habitats within both the intertidal and subtidal. The surveys are also relatively contemporary and cover a range of seasons.

9.6.54 Fish data was also 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) have also been reviewed (IECS, 2010). Further information on these surveys is provided in Section 9.3.

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 to1995 and found that 0-group sole were highest in the 2 to 5.9 m depth band (Rogers *et al.,* 1998).

Marine mammals

Humber Estuary overview

Seals

9.6.57 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.

9.6.58 The intertidal area at Donna Nook is the main haul out site in the region and is an important breeding ground for grey seals. In 2016, there were an estimated 60,500 grey seal pups born in Britain (SCOS, 2021) 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 breed at Donna Nook, with a few seals breeding on Skidbrooke Ridge, south of Donna Nook. Peak grey seal pup numbers in winter 2020/21 at Donna Nook consisted of 2,214 seals. This is 28 more than in 2019/2020 and 148 more than in 2018/2019 with numbers having increased substantially from under 100 pups born annually in the 1980s (Figure 9.6).

9.6.59 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 2019 recorded 5,265 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 5,000 seals in more recent years (SCOS, 2021) (Figure 9.7).

9.6.60 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.,* 2021).

9.6.61 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 128 common seals were recorded in 2019 as part of annual aerial monitoring in the region in August 2019. Since the 1990s numbers have generally fluctuated between 100 and 400 counts annually (SCOS, 2021). Common seals typically forage within 40 to 50 km of haul out sites (SCOS, 2021).

Cetaceans

9.6.62 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; Waggit *et al*., 2020).

9.6.63 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 strongly seasonal with most births in June or July and a peak in mating in August (Evans and Bertulli, 2021).

9.6.64 Other cetacean species recorded in the 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

9.6.65 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) approximately 4 km from the proposed development during the project specific benthic surveys as detailed in Appendix 9.1.

9.6.66 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.

Coastal waterbirds

Humber Estuary overview

9.6.67 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).

9.6.68 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 with the arrival of wintering waterfowl such as Pink-footed Geese and Wigeon as well as wader species such as Knot 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).

9.6.69 Table 9.15 provides summary ecology information on key waterbird species occurring in the Humber Estuary. 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).

Table 9.15. 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 as well as Salt End, Stone Creek, Paull Holme Stray, Cherry Cobb Sands and Pyewipe (all Middle Humber). 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 70 % worms, 14 %	Widespread with important areas including Read's Island (Inner Humber), Cherry Cobb Sands, Pyewipe, Stone Creek and Salt End (all Middle Humber) and Saltfleet (Outer 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]
			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 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
	Grey Plover		Polychaete worms (such as *Hediste*	Widespread usage across the Middle and Outer parts of the	Jan, Mar, May, Sep	3,179

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]
			diversicolor and *Arenicola marina*), bivalves (such as *Limecola balthica*) and the muds snail *Peringia ulvae.*	Humber, Typically more usage of the north bank compared to the south bank. Particular key areas include Cherry Cob Sands, and Welwick.		
	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 46 % worms, 7 %	Widespread with key areas including Cherry Cobb Sands and in the outer 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]
			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
	Bar-tailed Godwit		Polychaete worms are the principal food	The most important sectors for Bar-tailed Godwit are the	Feb, Sep, Nov	1,561

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]
			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.*	three sectors that make up the Outer (North) area, and the adjacent Cherry Cobb Sands (Middle Humber), and Paull Holme Strays (also Middle Humber).		
	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 proportions comprise 60 % worms, 1 %	Within the Humber Estuary, Sanderling are found exclusively in the outer estuary, particularly on the sandflats of the Lincolnshire coast.	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]
			molluscs and 39 % 'other'.			
	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
Water-fowl	Pink-footed Goose	Herbivorous waterfowl	Herbivorous. Outside the breeding season this species feeds on improved grasslands,	Recorded mainly on Read's Island, which it uses as a roosting site, flying inland	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]
			cereal stubbles and vegetables (e.g. potatoes, sugar beet, carrots).	during the day to feed in fields.		
	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

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]
	Dark-bellied Brent Goose	Herbivorous waterfowl	Mainly grasses, and on arable land the shoots of winter cereals, and oilseed rape. On estuaries, eelgrass *Zostera* spp. and saltmarsh plants.	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
	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.	Mallard occurs throughout the 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

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]
	Barnacle Goose	Herbivorous waterfowl	The leaves and stems of grasses, roots and seeds.	Present on fields/arable land around the entire Humber in low densities.	Jan-Mar, Sep	878
	Common Scoter	Benthivorous diving duck	Molluscs.	Present within the Outer Humber due to their more pelagic lifestyle.	Mar, Oct-Dec	682
	Canada Goose	Herbivorous waterfowl	Roots, grass, leaves and seeds.	Present within the Inner Humber to a greater extent. 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

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]
	Great Black-backed Gull		Shellfish, birds and carrion.	Widely distributed.	Sep-Dec, Feb	292
Terns and other seabirds	Sandwich Tern	Piscivorous plunge diver	Fish such as sandeels, sprats and whiting.	Widely distributed.	Jul-Aug	686
	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

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 (https://designatedsites.naturalengland.org.uk/)
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).

9.6.70 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 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*., 2019).

9.6.71 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).

9.6.72 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*., 2019). 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).

9.6.73 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.

9.6.74 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.

9.6.75 Sandwich Tern (5-year mean peak of 686 birds) and Common Tern (5-year mean peak of 476 birds) are regularly recorded, particularly in passage periods. Little Tern also breed at a few locations in the Humber Estuary area.

Immingham area

9.6.76 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 'Sector B' (between Marsh Lane (Immingham) Western Jetty to the IOT Jetty (as shown in Figure 9.1). The most recent 5-years of data (2016/17 to 2020/21) has been analysed for this sector. During this period, surveys were undertaken between October and March twice a month. 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 to this data, the 2021/22 survey season started in August rather than October (as per previous years) in order to better understand passage numbers. The initial results from this season (i.e. August and September 2021) have also been presented.

9.6.77 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[5] is presented in Table 9.16. The 5-year average of the annual peak counts for each species (referred to as the mean peak) [6] is also presented in Table 9.16. 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 a national (bullet one) and regional context (bullet two):

- **Nationally Important Threshold Level (NT):** The threshold for an individual species (or subspecies) is set at 1 % of the British population[7] 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. Within this assessment, this is from 2015/16 to 2019/20 (Frost *et al.,* 2021). For the purposes of this assessment, numbers representing more than 10 % of the estuary-wide Core Counts for an individual species are

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

6 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).

7 The thresholds levels are available at: https://www.bto.org/volunteer-surveys/webs/data/species-threshold-levels. It should be noted that, where 1 % of the national 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 10/4/21).

considered regionally important and numbers representing between 1 % and 10 % are considered locally important [8].

9.6.78 The 5-year mean peak number of birds in Sector B during different months is presented Figure 9.9 to show any seasonal trends over the winter period. To better understand passage numbers, the 2021/22 survey season started in August rather October as per previous years. The distribution of birds within Sector B based on distribution data collected in the surveys is shown in Figure 9.10.

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

9.6.80 The most abundant wading bird species recorded foraging within the area over this period were Dunlin and Black-tailed Godwit (5-year mean peaks of 388 and 334 birds respectively). It should be noted that in winter 2017/18 and 201919/20 Black-tailed Godwit were recorded in nationally important numbers (419 and 563 birds respectively) (Table 9.16). Other wading birds recorded included Redshank, Turnstone, Oystercatcher and Curlew. Shelduck were the most abundant wildfowl species recorded foraging (5-year mean peak of 67 birds). Lower numbers of other ducks such as Teal and Mallard were also recorded.

[8] 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 9.16. 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)					
	16/17	17/18	18/19	19/20	20/21	MP	16/17	17/18	18/19	19/20	20/21	MP	16/17	17/18	18/19	19/20	20/21	MP
Bar-tailed Godwit	15	29	2	22	10	16		2		12	12	5	15	29	2	22	12	16
Black-tailed Godwit	98	419	286	563	303	334	39	12	6	222	3	56	98	419	286	563	303	334
Common Sandpiper	1					< 1							1					< 1
Cormorant	1		4	3	2	2	21	19	14	6	14	15	21	19	14	7	14	15
Curlew	10	12	12	12	11	11	7	4	6	7	8	6	12	12	12	12	11	12
Dunlin	501	417	270	115	638	388	410	330	120	2	300	232	501	417	270	115	638	388
Golden Plover											1	< 1					1	< 1
Greenshank				1		< 1										1		< 1
Grey Heron				1	1	< 1	1	1			1	1	1	1		1	1	1
Grey plover		1	1		1	1			1		1	< 1		1	1		1	1
Knot	16	3		23	14	11	1			4	10	3	16	3		23	14	11
Lapwing		3				1		3		1		1		3		1		1
Little Egret										1		< 1				1		< 1
Mallard	2	2	4	8		3	2		6	2		2	2	2	8	8		4
Mute swan									1			< 1			1			< 1
Oystercatcher	5	5	8	10	8	7	6	3	5	6	4	5	7	6	8	10	9	8
Purple Sandpiper	1					< 1							1					< 1
Redshank	123	184	204	166	125	160	74	130	110	121	110	109	123	184	204	184	125	164
Ringed Plover		7	12	1	7	5								7	12	1	7	5
Shelduck	58	84	69	56	70	67	58	69	74	39	45	57	61	88	74	58	86	73
Spotted Redshank		1				< 1								1				< 1
Teal	2		11	21	9	9		2	1	9	3	3	2	2	11	21	9	9
Turnstone	30	22	35	33	29	30	15	5	15	5	6	9	30	22	35	33	29	30
SPA qualifying species highlighted in **bold**																		
	Cells highlighted green indicate the count is of local importance (> 1 %) of the current WeBS 5-year MP.																	
	Cells highlighted orange indicate the count is of regional importance (> 10 %) of the current 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 WeBS 5-year MP – 455 birds) is higher than the national importance threshold (390 birds). The national importance threshold for Common Sandpiper and Spotted Redshank is set as 1.																	

9.6.81 With respect to roosting birds, Dunlin and Redshank were the most numerous species recorded (5-year mean peaks of 232 and 109 birds respectively). Other species regularly recorded roosting included Shelduck (5-year mean peak of 57 birds) as well as Black-tailed Godwit, Curlew and Turnstone.

9.6.82 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.

9.6.83 The additional data collected in August and September 2021 recorded a range of species during this period. For example, a peak count of 143 Redshank was recorded in September 2021 (which is close to the winter 5-year mean peak of 164 birds). A peak of 30 Turnstone was recorded during August (which is the same number as the winter 5-year mean peak). Other species such as Black-tailed Godwit and Dunlin were recorded in lower numbers during this period (peak of 91 birds and 20 Dunlin respectively). All these species are frequently recorded in large numbers during both passage and winter periods in the Humber Estuary with the estuary-wide abundance of passage birds showing a high degree of annual variability.

9.6.84 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 (towards the IOT Jetty). Birds typically cluster along the tideline and use this entire area extensively. Very few waterbirds are recorded west of the lock gate with occasional individuals of Dunlin, Curlew, Redshank or Turnstone recorded. Waders tend to roost on a slightly higher elevation area of mudflat with low numbers moving to the seawall. An outfall pipe is also used by roosting Turnstone and Cormorant. In addition, Turnstone and gulls use derelict concrete structures present on the mudflat (Figure 9.10).

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).

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 Preliminary 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 IERRT project which have been identified at this preliminary stage.

9.8.2 The Physical Processes assessment (Chapter 7), Water and Sediment Quality assessment (Chapter 8) and underwater noise assessment (Appendix 9.2) 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) will be assessed within the HRA which will be included in the ES (Chapter 5, Section 5.8). 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.

9.8.4 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.

9.8.5 The Lagoons SSSI (located approximately 20 km from the Proposed Development) and Greater Wash SPA (located approximately 70 km from the proposed development) have limited functional links to the proposed development as coastal waterbirds typically show site fidelity to relatively localised areas. Potential effects on these sites are, therefore, considered to be negligible.

9.8.6 Cumulative impacts on marine ecology receptors could arise as a result of other coastal and marine developments and activities in the Humber Estuary will be considered as necessary as part of the cumulative impacts and in-combination effects assessment, the approach to which is explained further in Chapter 20 of this PEIR.

Construction phase

9.8.7 Based on current understanding of the nature and scale of the proposed development, read together with the environmental baseline and stakeholder comments from the Scoping Opinion, the potential effects during the construction phase that are considered may be relevant are reviewed in Table 9.17. It should be noted that the table includes the rationale, albeit at this preliminary stage, for the scoping in or out of individual pathways for further assessment.

Table 9.17. Potential effects during construction scoped in and out of further detailed assessment

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 piling	Capital dredge and piling	yes	Capital dredging will cause a direct 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 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	At this stage it is not known whether the dredged arisings will be disposed at sea. That said, 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 of sediment deposition	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 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.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
		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	If disposal at sea is unavoidable, this 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 changes to seabed habitats and species as a result of changes to hydrodynamic and sedimentary processes	Piling	No	The pile structures have the potential to result in changes to hydrodynamic and sedimentary processes (e.g. flow rates, accretion and erosion patterns). However, such effects are anticipated to be negligible and highly localised (which has been confirmed by the Physical Processes assessment included in Chapter 7 of the PEIR) and marine 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	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). 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

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				and change the distribution of marine species. This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	Yes	The disposal of dredged material at the marine disposal site if a beneficial alternative option cannot be identified, 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 expected 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

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				sediments. This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	Yes	If it is finally determined that the dredged arisings will have to deposited at sea, 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 disturbance	Piling	Yes	Underwater noise generated by piling has the potential to affect benthic species. This will require further 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 further 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 further assessment and has, therefore, been scoped in.
	The potential introduction and spread of non-native species	Approach jetty and finger piers marine works	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.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	Yes	Whilst the decision as to how to dispose the dredged arisings has not yet been finally made, if this proves to be the only option available, 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 proposed development 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 TSHD 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.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
		Dredge disposal	Yes	If no beneficial use for the dredged arisings is identified, 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 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), insignificant changes in estuary processes are predicted. The predicted changes are unlikely to be discernible against background natural processes and 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,

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				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), 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 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 negligible, highly localised and temporary changes in suspended sediment levels (Chapter 7) and related changes in sediment bound contaminants and dissolved oxygen (Chapter 8) 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.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
		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	If the dredged material is disposed of at sea, 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.
	Underwater noise disturbance	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	If disposal at sea proves to be the only option, elevated 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.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
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 expected negligible, highly localised and temporary changes in suspended sediment levels (Chapter 7) and related changes in sediment bound contaminants and dissolved oxygen (Chapter 8) associated with bed disturbance 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 (Chapter 7). 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). In addition, the temporary and localised changes in water column contamination levels are considered unlikely to

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				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, 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.
		Dredge disposal	No	If disposed at sea, the plumes resulting from dredge disposal are expected to have a relatively minimal and local effect on SSC in the vicinity of the proposed development (Chapter 7). 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 (Chapter 8). 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, potential for accidental spillages will also be negligible during all phases through the application of

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				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, making the risk of collision very low. Furthermore, the region is already characterised by heavy shipping traffic. Marine mammals foraging within the Humber Estuary routinely need to avoid collision with vessels and are, therefore, considered well 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 disturbance	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 pathway has, therefore, been scoped into the assessment.
		Dredge disposal	Yes	If no beneficial use can be identified and the arisings have to be disposed at sea, 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

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				behavioural reactions. This impact pathway has, therefore, been scoped into the assessment.
Coastal waterbirds	Direct loss or change to coastal waterbird habitat	Piling	Yes	Piling will cause a direct loss of intertidal habitat. This loss will be highly localised. However, 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 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.
		Dredge disposal	No	Dredge disposal at sea, if this proves to be the only available course, 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) which will provide 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.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
		Dredge disposal	No	During dredge disposal, if this proves to be the only option for disposal of the dredged material, 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

9.8.8 This section contains a preliminary assessment of the potential impacts to benthic ecology receptors as a result of the construction phase of the IERRT project. A preliminary assessment of the following impact pathways has been undertaken:

- Direct loss of intertidal habitat as a result of capital dredging and piles;
- Changes to benthic habitats and species as result of the removal of seabed material during dredging;
- Changes to habitats and species as a result of sediment deposition during dredging and dredge disposal;
- Indirect changes to benthic habitats and species as a result of changes to hydrodynamic and sedimentary processes during capital dredging and dredge disposal;
- Changes in water and sediment quality during capital dredging and dredge disposal;
- Underwater noise and vibration disturbance during piling, capital dredging and dredge disposal; and
- Introduction and spread of non-native species.

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

General scientific context

9.8.9 The impact of direct habitat loss (e.g. piling) mainly relates to the temporary or permanent physical removal of substratum and associated organisms from the seabed.

9.8.10 Both intertidal and 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 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

9.8.11 The development, as currently proposed, will result in the direct loss of 1.65 ha of intertidal habitat due to the following:

- Capital dredging will cause a direct loss of 1.64 ha of intertidal habitat which will be changed to subtidal habitat as a result of the deepening; and
- The piles will cause a direct loss of 0.01 ha of intertidal mudflat habitat.

9.8.12 The habitat loss represents approximately < 0.005 % the Humber Estuary SAC and Humber Estuary SPA/Ramsar and < 0.02 % of intertidal habitat within the Humber Estuary SAC.

9.8.13 The project-specific intertidal benthic survey recorded sandy mud habitat 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 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). Species such as *Corophium volutator, Peringia ulvae, Limecola balthica* and polychaetes are considered important 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'.

9.8.14 Based on the evidence provided above, the probability of habitat loss occurring is high and the magnitude of potential impacts is considered to be small. This is because while the loss is considered negligible in the context of the amount of similar habitat in the region (and as a proportion of internationally designated sites), the habitat and benthic assemblage it supports is considered to be functionally important for local populations of waterbirds. Exposure to change is, therefore, considered to be low. 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) leading to a high to moderate vulnerability. While the benthic community is considered commonly occurring in the region, intertidal habitat is protected and of functional importance for waterbirds. On this basis, importance is considered to be high. The impact is therefore considered to be **moderate adverse**.

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

General Scientific Context

9.8.15 Dredging causes a direct physical removal of subtidal sediments, causing a modification to the existing subtidal habitat. 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.

9.8.16 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).

9.8.17 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 and Rees, 2003).

Project Impact Assessment

9.8.18 Based on the current project design, the capital dredge will remove approximately 330,000 m³ of material over a maximum area of approximately 90,000 m² (see Chapter 2, Section 2.3). It is currently expected that the majority or all of the material will be removed with a backhoe dredger. Some material may also be removed by trailer suction hopper dredger (TSHD).

9.8.19 The capital dredge will result in the loss of 1.64 ha of lower elevation intertidal habitat as a direct result of deepening the berth pockets (i.e. it will permanently change to subtidal habitat). This has already been assessed above. In addition, the dredging will cause changes to 6.47 ha of subtidal habitat as a direct result of the physical removal of subtidal sediment, as well as a change over 0.48 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.

9.8.20 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. The project-specific intertidal survey (Section 9.6 and Appendix 9.1 in Volume 3 of the PEIR) 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*. The subtidal survey recorded a benthic community characterised by nemotodes, the mudsnail *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. These species are also typically fast growing and/or have rapid

reproductive rates which allow populations to re-establish sometimes within a few months (Ashley and Budd, 2020; De-Bastos and Hiscock, 2016; Tillin, 2016; Ashley, 2016). The benthic communities would, therefore, be expected to recolonise the dredge footprint relatively quickly.

9.8.21 The lowering in elevation of intertidal around the dredge pocket (0.48 ha) could result in some localised changes in infaunal composition. However, the key characterising species are likely to be similar. Overall, there is no reason to suggest that this lower elevation mudflat will be ecologically poorer or provide a lower functionality in terms of prey resources for waterbirds.

9.8.22 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 and intertidal 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 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. While both the subtidal and intertidal benthic communities are considered commonly occurring in the region, intertidal habitats are protected and of functional importance for waterbirds. Importance is, therefore, considered to range from low (for subtidal habitats) to high (for intertidal habitats). Overall, the potential effect is assessed at this preliminary stage as **insignificant** for subtidal habitats and **minor adverse** for intertidal habitats.

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

General Scientific Context

9.8.23 Sediments suspended and dispersed during the marine works, dredging and disposal (if there is no suitable beneficial alternative) 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).

9.8.24 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.

9.8.25 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).

9.8.26 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

9.8.27 Sediment changes that are predicted to occur as a result of the capital dredging are considered in more detail in the Physical Processes assessment (Chapter 7). In summary, maximum siltation as a result of the capital dredge within about 100 m from the edge of the dredge pocket is expected to be 7 to 8 mm reducing to around 3 mm within approximately 500 m from the dredged pocket. Beyond these areas, the majority of deposition levels is 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.

9.8.28 The project-specific intertidal survey (Section 9.6 and Appendix 9.1 in Volume 3 of the PEIR) 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*. The subtidal survey recorded a benthic community characterised by nemotodes, the mudsnail *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.

9.8.29 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 typically rapidly recolonise disturbed habitats, many within a few months following the disturbance events (Ashley and Budd, 2020; De-Bastos and Hiscock, 2016; Tillin, 2016; Ashley, 2016).

9.8.30 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, intertidal habitats are protected and of functional importance for waterbirds. Importance is, therefore, considered to range from low (for subtidal habitats) to high (for intertidal habitats). The overall potential impact of deposition on benthic features is assessed at this preliminary stage as **insignificant**.

Project Impact Assessment: Disposal

9.8.31 Subject to no appropriate alternative use being identified for the dredge material, it is anticipated that any 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).

9.8.32 A preliminary 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). In summary, sedimentation resulting from the disposal plume is predicted to be a maximum of 4 to 6 mm within approximately 4 km of the disposal sites.

9.8.33 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.

9.8.34 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 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 based on the current scheme design at this preliminary stage.

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

9.8.36 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 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 high. The overall potential impact of deposition on benthic features is assessed as **insignificant** at this preliminary stage.

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

General Scientific Context

9.8.37 Port or harbour structures (such as breakwaters, coastal defences, jetties or quay walls) can cause changes to hydrodynamics (flow speeds, flow direction, waves, water levels) and seabed morphology (Prum 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.

9.8.38 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).

9.8.39 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.

9.8.40 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). Therefore, 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: Capital Dredging

9.8.41 A preliminary assessment of the hydrodynamic and sediment regime changes that are predicted to occur as a result of the capital dredging are considered in more detail in the Physical Processes assessment (Chapter 7). Marginal changes to hydrodynamics (local flow speed) are likely to occur following the capital dredge with only small changes in sedimentation and erosion rates predicted to occur for subtidal habitats in the vicinity of the dredge pocket. Negligible changes in erosion and accretion are predicted to occur on nearby intertidal habitats

9.8.42 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 consequently assessed as negligible. The marine habitats which have the potential to be 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. While both the subtidal and intertidal benthic communities are considered commonly occurring in the region, intertidal habitats are protected and of functional importance for waterbirds. Importance is therefore considered to range from low (for subtidal habitats) to high (for intertidal habitats). Based on these factors, the potential effect is assessed as **insignificant** at this preliminary stage.

Project Impact Assessment: Disposal

9.8.43 A preliminary 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).

9.8.44 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.

9.8.45 As currently understood, such changes are unlikely to result in any significant changes to local sediment transport in the region although some localised changes to seabed bathymetry and morphology could occur.

9.8.46 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).

9.8.47 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. Therefore, importance is assessed as medium. The overall impact is, therefore, assessed as **insignificant** at this preliminary stage.

Changes in water and sediment quality during dredging and dredge disposal

General Scientific Context

Elevated suspended sediment concentrations

9.8.48 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).

9.8.49 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.

9.8.50 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.

9.8.51 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

9.8.52 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).

9.8.53 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

9.8.54 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.

9.8.55 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).

9.8.56 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

9.8.57 The changes in SSC that are predicted to occur as a result of the capital dredge as currently proposed are considered in more detail in the Physical Processes assessment (Chapter 7). 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.

9.8.58 Naturally very high SSC typically occur year around in the Humber Estuary, particularly during the winter months when storm events disturb the seabed and on spring tides. 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).

9.8.59 In summary, the predicted increases in SSC due to the capital dredging will be localised and temporary based on the preliminary Physical Processes assessment (Chapter 7). 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, intertidal habitats are protected and of functional importance for waterbirds. Importance is therefore considered to range from low (for subtidal habitats) to high (for intertidal habitats). The overall effect of suspended sediments on benthic habitats and species is assessed as **insignificant** at this preliminary stage.

Release of contaminants

9.8.60 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).

9.8.61 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) 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.

9.8.62 Based on existing available information, the overall level of contamination in the proposed dredge area is considered to be low with only a small proportion of disturbed material expected to be raised into suspension. 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 is

considered to 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, intertidal habitats are protected and of functional importance for waterbirds. Importance is therefore considered to range from low (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** at this preliminary stage.

Project Impact Assessment: Disposal

Elevated suspended sediment concentrations

9.8.63 The hydrodynamic and sediment regime changes that are predicted to occur as a result of the dredge disposal if disposal at sea proves to be the only option are considered in more detail in the preliminary Physical Processes assessment (Chapter 7). 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. 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.

9.8.64 Naturally very high SSCs typically occur year around in the Humber Estuary, particularly during the winter months when storm events disturb the seabed and on spring tides. 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).

9.8.65 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.

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 medium. The overall impact is, therefore, assessed as **insignificant** at this preliminary stage.

Release of contaminants

9.8.66 The results of the sediment contamination sampling are summarised above and the Water and Sediment Quality chapter (Chapter 8). 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.

9.8.67 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. Therefore, importance is assessed as medium. The overall impact is, therefore, assessed as **insignificant** at this preliminary stage.

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

General scientific context

9.8.68 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.

9.8.69 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).

9.8.70 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.

Project impact assessment: Piling

9.8.71 Based on the evidence provided in the above scientific context review of the potential effects of underwater noise, population level and mortality effects in benthic invertebrates are considered unlikely. The proposed development will involve the installation of approximately 162 steel tubular piles, which will range in size from 965 mm to a maximum of 1,321 mm diameter. The piling will be undertaken predominantly by a vibrating hammer until refusal with impact driving only used to provide the final level. Furthermore, the piling works will be temporary and short term (anticipated to be completed within a 20-week period).

9.8.72 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 around 20 weeks. 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. While both the subtidal and intertidal benthic communities are considered commonly occurring in the region, intertidal habitats are protected and of functional importance for waterbirds. Importance is therefore considered to range from low (for subtidal habitats) to high (for intertidal habitats). On this basis, the impact of piling noise and vibration on benthic invertebrates is assessed at this preliminary stage as **insignificant.**

Project impact assessment: Capital dredge and disposal

9.8.73 Based on the above review of the potential effects of underwater noise, population level and mortality effects in benthic invertebrates are considered unlikely. 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.

9.8.74 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 or blasting. Furthermore, the proposed capital dredge and disposal activities will be short term and temporary, lasting a period of around 100 days (14 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, 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 low to high. On this basis, the impact of dredging and disposal noise and vibration on benthic invertebrates is assessed as **insignificant** at this preliminary stage.

The potential introduction and spread of non-native species

General Scientific Context

9.8.75 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).

9.8.76 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).

9.8.77 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.

9.8.78 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.

9.8.79 The UK is bound by international agreements such as the Convention on Biological Diversity, the United Nations Convention on the Law of the Sea, 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 (1981) 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 Act.

Project Impact Assessment

9.8.80 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.

9.8.81 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. These measures will be included within the Construction Environmental Management Plan (CEMP). 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 low (for subtidal habitats). The overall impact at this preliminary stage is, therefore, considered to be **insignificant to minor adverse.**

Fish

9.8.82 This section contains a preliminary assessment of the potential impacts to fish receptors as a result of the construction phase of the IERRT project. A preliminary 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;
- Changes in water and sediment quality as a result of dredging and dredge disposal; and
- Underwater noise disturbance and vibration disturbance during piling, capital dredging and dredge disposal.

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)

9.8.83 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

sandeel and whiting are invertebrate and piscivorous feeders. However, a change in dietary composition as a result of dredging may not 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)

9.8.84 Should the removal of seabed sediments during dredging lead to habitat loss, it could potentially impact on critical 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 than those that spawn into the water column. For example, Herring use coarse sediments as spawning grounds. Herring along with sandeel species which live within the sediment are considered particularly sensitive to habitat change (Tillin *et al.,* 2011).

Direct effects (uptake)

9.8.85 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).

9.8.86 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).

9.8.87 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

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

9.8.89 As presently proposed, however, the dredge footprint is considered unlikely to provide important nursery or spawning functions for fish species as a result of the 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.

9.8.90 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 in Volume 3 of the PEIR) (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).

9.8.91 During backhoe 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 shallow water. However, the 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 dredge footprint and nearby area is, therefore, likely to provide disturbed and sub-optimal spawning conditions with more optimal habitat present in the wider Humber Estuary area. In addition, the dredge footprint is considered negligible in the context of suitable spawning habitat in the region.

9.8.92 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** at this preliminary stage.

Project Impact Assessment: Disposal

9.8.93 The disposal of dredged material at the marine disposal sites, if no alternative option can be identified, will result in the deposition of sediments which has the potential to cause physical disturbance and smothering of seabed habitats.

9.8.94 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 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.

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

9.8.96 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** at this preliminary stage.

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

General Scientific Context

Elevated suspended sediment concentrations

9.8.97 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.

9.8.98 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).

9.8.99 Elevated suspended sediments can also influence the movements and migrations 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

9.8.100 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

9.8.101 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.

9.8.102 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).

9.8.103 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

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

9.8.105 As noted in the preceding section, fish within the area are well adapted to living in an area with variable and sometimes relatively 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.

9.8.106 Therefore, while the probability of a localised and temporary change is high, magnitude of change will be negligible and consequently exposure to change is assessed as negligible. Sensitivity of fish is assessed as low at worst and consequently vulnerability is assessed as none. 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** at this preliminary stage.

9.8.107 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. 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, at this preliminary stage, any impact is likely to be **insignificant.**

9.8.108 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.

9.8.109 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 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** at this preliminary stage**.**

Project Impact Assessment: Dredge disposal

9.8.110 The changes in SSC that are predicted to occur as a result of the disposal activities are considered in more detail in the preliminary Physical Processes assessment (Chapter 7) and summarised above in the 'Benthic Habitats and Species' impact assessment sub-section.

9.8.111 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. Magnitude of change is, therefore, 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** at this preliminary stage.

9.8.112 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). 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.

9.8.113 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. 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. Therefore, while the sensitivity of fish is low to moderate and certain species have a high nature conservation importance, any impact will be **insignificant** at this preliminary stage.

Underwater noise disturbance

General scientific context

9.8.114 Elevated underwater noise and vibration levels during construction activities can potentially disturb marine animals 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, Volume 3 of the PEIR) and is briefly summarised in this section.

9.8.115 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.

9.8.116 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.

9.8.117 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[9] 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[10], particle motion is considered equally or potentially more important (Hawkins and Popper, 2017).

9.8.118 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.

9.8.119 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.

9.8.120 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*).

9.8.121 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*).

9 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.

10 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

9.8.122 The distances at which potential mortality/injury and behavioural effects in fish are predicted to occur as a result of the percussive piling associated with the development as it is currently proposed are included in Appendix 9.2 (Volume 3 of the PEIR).

9.8.123 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 25 m from the source of piling in fish with a swim bladder (such as herring, Atlantic salmon and European eel) and within 12 m in fish with no swim bladder (such as lamprey and flatfish).

9.8.124 The calculator developed by 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, there is predicted to be a risk of mortality and potential mortal injury within 82 m from the source of piling in fish with a swim bladder involved in hearing (such as herring), within 56 m from the source in fish with a swim bladder not involved in hearing (such as European eel) and within 18 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 138 m in fish with a swim bladder and 26 m in fish without a swim bladder.

9.8.125 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.

9.8.126 The range at which the Hawkins *et al*. (2014) quantitative instantaneous peak SPL behaviour thresholds for pile driving are reached indicates that there is a risk of a behavioural response in fish within around 2.6 km from the impact piling.

9.8.127 Behavioural reactions are anticipated to occur across the entire width of the estuary at low water and the majority of the estuary width (77 %) at high water. 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 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 anticipated to only show very subtle changes in behaviour in this zone.

9.8.128 The scale of the behavioural effect is also dependent on the size of fish (which affects maximum swimming speed). The Physical Processes chapter (Chapter 7) notes that peak flows above 1.8 m/s are recorded in the area of the Humber Estuary fronting the Port of Immingham. Assuming that fish are not swimming actively but instead moving only passively with tidal flows, they would take around 49 minutes to travel up or down estuary through the zone of behavioural disturbance during impact piling. 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, are able to move out of the behavioural effects zone in less time.

9.8.129 The effects of piling noise on fish also need to be considered in terms of the duration of exposure. It is presently anticipated that piling noise will take place over a period of approximately 20 weeks. Piling will not take place continuously as there will be periods of downtime, pile positioning and set up.

9.8.130 As currently proposed, the piling works will be undertaken 7 am to 7 pm (Monday to Friday) and 7 am to 1 pm (Saturday). 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 around 180 minutes of impact piling per day in a 12-hour shift. There will, therefore, be significant periods over a 24-hour period when fish will not be disturbed by any impact piling noise. The actual proportion of impact piling is estimated to be at worst around 11 % (based on a worst case 180 minutes of impact 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 percussive piling will be exposed a maximum of up to 11 % of the time. Furthermore, piling during daytime hours will benefit migratory species that tend to move at night, such as the European eel.

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

9.8.132 Applying the standard impact assessment criteria, the probability of occurrence of underwater noise disturbance during piling is high. There is considered 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 could occur over the entire width

of the 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.

9.8.133 The sensitivity of Atlantic salmon, sea trout, European smelt, shads and European eel is considered to be medium 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 in duration, the effect to Atlantic salmon, sea trout, European smelt, shads, European eel is considered to be **moderate adverse** and the effect to lamprey species **minor adverse** at this preliminary stage.

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

Project impact assessment: Capital dredge and dredge disposal

9.8.135 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 (Volume 3 of the PEIR).

9.8.136 The worst case 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.

9.8.137 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.

9.8.138 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) whereby 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.

9.8.139 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.

9.8.140 The range at which the Hawkins *et al.* (2014) quantitative instantaneous peak SPL behavioural threshold is reached is within around 52 m from dredging, noting that this will be a moderate behavioural response in fish with a swim bladder or air cavities that aid hearing and a minor behavioural response in fish with a swim bladder that does not aid hearing and fish without a swim bladder. This broadly correlates with the Popper *et al.* (2014) qualitative behavioural guidelines discussed above.

9.8.141 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. 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. 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 100 days (14 weeks) in total).

9.8.142 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. Therefore, while sensitivities of fish to underwater noise is considered to range from low to medium 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, at this preliminary stage, considered to be **insignificant.**

Marine mammals

9.8.143 This section contains a preliminary assessment of the potential impacts to marine mammal receptors as a result of the construction phase of the IERRT project. A preliminary assessment of the following impact pathway has been undertaken:

- Underwater noise disturbance and vibration disturbance during piling, capital dredging and dredge disposal.

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

General scientific context

9.8.144 Elevated underwater noise and vibration levels during construction activities can potentially disturb marine animals 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, Volume 3 of the PEIR) and is briefly summarised in this section.

9.8.145 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.

9.8.146 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.

9.8.147 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.

9.8.148 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.

9.8.149 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 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”).

9.8.150 There are no equivalent behavioural response criteria. 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). 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. A review of the available evidence on the behavioural responses of harbour porpoise and seals to anthropogenic noise is included in Appendix 9.2 (Volume 3 of the PEIR).

Project impact assessment: Piling

9.8.151 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 for the proposed development are included in Appendix 9.2 (Volume 3 of the PEIR).

9.8.152 There is predicted to be a risk of instantaneous PTS and TTS in harbour porpoise within 47 m and 102 m respectively from the source of the percussive piling noise. The risk of instantaneous PTS and TTS in seals is within 6 m and 13 m respectively.

9.8.153 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 2.1 km and 14.3 km respectively. The maximum distance for PTS and TTS in seals is 1.1 km and 7.3 km respectively.

9.8.154 Assuming a lower worst case 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 23 minutes and 2.7 hours respectively. This is less than 11 % 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 impact piling. The maximum time that would take seals to leave the PTS and TTS zones is estimated to be 12 minutes and 1.4 hours respectively. This is less than 6 % 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.

9.8.155 Impact piling is predicted 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.

9.8.156 The results indicate that if any marine mammals present in the 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 stay within this “injury zone” during the piling operations.

9.8.157 Any marine mammals present are likely to evade 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).

9.8.158 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 over a period of approximately 20 weeks. Piling will not take place continuously as there will be periods of downtime, pile positioning and set up.

9.8.159 It is currently proposed that piling works will be undertaken 7 am to 7 pm (Monday to Friday) and 7 am to 1 pm (Saturday). 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 around 180 minutes of impact piling per day in a 12 hour shift. There will, therefore, be significant periods over a 24-hour period when fish will not be disturbed by any impact piling noise. The actual proportion of impact piling is estimated to be at worst around 11 % (based on a worst case 180 minutes of impact 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 percussive piling will be exposed a maximum of up to 11 % of the time.

9.8.160 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.

9.8.161 Applying the standard impact assessment criteria, at this preliminary stage in the assessment, the probability of occurrence of underwater noise disturbance during piling is high. The magnitude of the change is 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 and their importance is considered to be high for all marine mammal species given the level of

protection that they are afforded. Therefore, the temporary underwater noise effect on marine mammals during piling is currently assessed as **minor to moderate adverse**.

Project impact assessment: Capital dredge and dredge disposal

9.8.162 The distances at which PTS, TTS and behavioural effects in marine mammals that occur in the study area are predicted to occur as a result of the dredging and vessel movements to and from the disposal sites (if a suitable alternative use is not identified) associated with the proposed development are included in Appendix 9.2 (Volume 3 of the PEIR).

9.8.163 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.

9.8.164 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.

9.8.165 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.

9.8.166 The probability of a change in underwater noise occurring during dredging and dredge disposal is considered to be 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, magnitude of the change due to dredging noise is currently considered to be negligible. The sensitivity of marine mammals to dredging noise is 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 are, at this preliminary stage, considered to be **insignificant.**

Coastal waterbirds

9.8.167 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 pathways have been assessed:

- Direct loss or change to coastal waterbird habitat; and
- Noise and visual disturbance.

Direct loss or change to coastal waterbird habitat

General scientific context

9.8.168 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).

9.8.169 Habitat loss can also result in increased densities of birds already using a site, increasing the potential for interference 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, presumably as a result of the increased densities in recipient areas.

Project impact assessment

9.8.170 As noted above, it is currently anticipated that the proposed development will result in the direct loss of 1.65 ha of intertidal habitat due to the following:

- Capital dredging will cause a direct loss of 1.64 ha of intertidal habitat which will be changed to subtidal habitat as a result of the deepening; and
- The piles will cause a direct loss of 0.01 ha of intertidal mudflat habitat.

9.8.171 Furthermore, it is predicted that 0.48 ha of intertidal habitat will become lower in elevation due to the slope of the proposed dredge pocket.

9.8.172 In the context of the Humber Estuary SPA, this habitat loss is considered to be negligible (representing 0.0044 %). Furthermore, this section of foreshore only supports a relatively small proportion of the overall Humber Estuary populations of the species commonly recorded. Nevertheless, this area is still used by a variety of species for feeding including Dunlin, Black-tailed Godwit, Redshank, Turnstone, Oystercatcher, Curlew and Shelduck. Key prey items for these species recorded in the benthic surveys included polychaetes (such as the ragworm *Hediste diversicolor* and *Pygospio elegans*), the mudsnail *Peringia* spp. and mud shrimp *Corophium* spp. and bivalve *Limecola balthica* (see Section 9.6 and Appendix 9.1 in Volume 3 of the PEIR).

9.8.173 The species and size of the prey taken varies between different coastal waterbirds. Larger waders are capable of consuming larger invertebrate prey items than small 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). The benthic prey recorded in the surveys were typically small size classes that are consumed by both smaller and larger wading bird species.

9.8.174 There is no evidence to suggest that mudflat in the nearby area is at carrying capacity. While the habitat loss would be expected to cause a small and localised reduction in the prey resources available for birds feeding in the local area, waterbirds would be expected to move to nearby foreshore which is likely to provide similar feeding opportunities. The habitat change is, therefore, considered unlikely to be at scale that would cause changes to diet or prey consumption levels to an extent that 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) are affected. Nevertheless, the loss of habitat still represents a loss of a protected habitat which is of functional value for a range of species for feeding and roosting. Many wintering waders tend to exhibit a relatively high-degree of site-fidelity and can be sensitive to habitat loss and displacement effects caused by proposed development with research suggesting that species that are site faithful sometimes show reluctance to move to alternative sites. When birds do relocate to new sites, the nearest alternative sites are often chosen, despite these areas potentially being of lower quality habitat (e.g. reduced prey resources, subject to higher disturbance pressure or which have a low carrying capacity to support displaced birds) (Woodward *et al.* 2014; Wright *et al*., 2014; Méndez *et al,* 2018; Burton, 2000).

9.8.175 The lowering in elevation of intertidal around the dredge pocket (0.48 ha) could result in some localised changes in infaunal composition. However, the key characterising species are likely to be similar. Overall, there is no reason to suggest that this lower elevation mudflat will be ecologically poorer or provide a lower functionality in terms of prey resources for waterbirds. The lowering would also be expected to cause a reduction in the potential time available for feeding within this area. However, this area would be highly localised with any associated changes in bird distribution as a result expected to be small scale, with foraging birds able to freely move a few tens of metres into nearby higher elevations when the mudflat in this area becomes inundated.

9.8.176 Overall, the probability of occurrence is considered to be high with magnitude of change considered to be medium, leading to a medium exposure to change. Local populations of waterbirds are considered to have a low to moderate sensitivity to the scale of habitat loss and change predicted. On this basis, vulnerability is considered to be low to moderate. 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, at this preliminary stage, is considered to be of **minor to moderate adverse** significance.

Noise and visual disturbance

General scientific context

9.8.177 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).

9.8.178 Disturbance often occurs through a combination of visual and noise stimuli simultaneously, 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*., 2002., Rees *et al*., 2005; Liley and Fearnley, 2011; Coleman *et al.*, 2003; Ruddock and Whitfield, 2007; Stillman *et al.*, 2012). The level 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, Dunlin and Sanderling) and gulls (Collop *et al*., 2016; Calladine *et al*., 2006; IECS, 2013). Flight initiation distance (FID), the distance at which a bird take flight in response to a perceived danger), have all been used to estimate the disruption of human activities to foraging birds. Collop *et al*. (2016) investigated energy and time costs of wintering waders responding to disturbance at four relatively undisturbed intertidal sites in the Wash embayment. The study collected data on FID, time spent in flight following disturbance (by walkers), time taken to resume feeding and total feeding time lost through experimentally disturbing 10 species of wading bird. In total birds were disturbed 677 times and the birds responses to the experimental disturbances recorded. The study found that Curlew had a mean FID of 340 m, Grey Plover 132 m, Bar-tailed Godwit 84 m and Redshank 80 m with smaller waders such as Turnstone and Dunlin having lower FIDs (32 and 44 m respectively).

9.8.179 The response to disturbance is dependent is also dependant on their previous experience of the 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).

9.8.180 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). 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.

9.8.181 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.*, 2002).

9.8.182 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). 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), 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.

9.8.183 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).

9.8.184 Studies into the distances from activities that evoke a disturbance response (or FID) suggest that for most coastal construction and other foreshore activity, disturbance behaviour is not typically observed when activities occur more than 250 to 300 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). As discussed previously in the above section, disturbance due to construction activities has been shown to cause similar or less disturbance than that of other nearby activities (such as recreational activities on the foreshore or water) (ERM, 1996; ABPmer, 2013; IECS, 1997; IECS, 2013).

9.8.185 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 9.18). 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 9.18. 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.

Study	Summary
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.
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.

9.8.186 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 are likely to become accustomed to after a short period (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).

Project impact assessment: RoRo terminal (construction and capital dredging)

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

- Piling: Noise stimuli caused by the vibro and percussive piling activity;
- Jack-up or crane barges: The presence of jack-up or crane barges used in construction will potentially cause both noise and visual disturbance;
- Capital dredging; and
- Construction machinery, construction workers and plant activity as part of the landside works.

9.8.188 Evidence suggests that waterbirds generally show a flight response to construction activities and a presence of people (such as construction workers) on or near the foreshore at distances <300 m (and typically between 20 m and 100 m). However, distances over 300 m have been recorded for some sensitive species (ABPmer, 2002; Ruddock and Whitfield, 2007; IECS, 2009a; Wilson, 2009; IECS, 2009b; Dwyer, 2010; IECS, 2013; Ross and Liley, 2014; Collop *et al*. 2016).

9.8.189 The bird data suggest that the foreshore fronting the proposed development is regularly used by up to 800 to 1200 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 . The sensitivity of these species to disturbance stimuli varies considerably. For example, Shelduck, godwit species and Curlew are considered particularly sensitive to construction related visual disturbance and typically they approach construction works no closer than 200 to 300 m whereas species such as Redshank, Turnstone and Dunlin are considered to generally be tolerant to visual stimuli associated with construction at distances of 50 to 100 m or more from the activity (IECS, 2013).

9.8.190 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). Other research has also indicated that in general, birds appear to habituate to continual noises (such as piling and engine noise) as long as there is no large amplitude ‘startling’ component (Hockin *et al*. 1992; IECS, 2009).

9.8.191 High level responses to noise (such as dispersal away from marine works) are typically associated with sudden noise over 60 dB (at the receiver (i.e. bird) location not the noise source) or irregular noise over 70 dB (IECS, 2013). However, visual disturbance associated with construction activity will often create a disturbance effect before any associated noise starts to have an effect particularly in those species sensitive to visual stimuli (IECS, 2013).

9.8.192 It should be noted that the predicted noise levels associated with piling and other construction activities (used to predict potential responses of birds based on established threshold responses highlighted in IECS, 2013) were not available in time for the PEIR but will be included in the ES.

9.8.193 It is considered very difficult to predict the specific responses given the interspecific differences between species and given that waterbirds present in the area are expected to be habituated to some extent to anthropogenic activities (due to existing port operations). Nevertheless, the very close proximity of the foreshore to construction activities which are known to evoke responses in waterbirds means that dispersive disturbance events

resulting in the redistribution of flocks to nearby areas is considered likely to occur relatively frequently for the duration of the construction. This could, therefore, potentially cause birds to temporarily avoid the area (i.e. short-term, localised displacement). Rather than evacuating the local region completely, 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.

9.8.194 The area in which disturbance and temporary displacement effects could occur is likely to be anything between 50 m and 300 m from the edge of the construction works depending on the species and activity as discussed above. This zone of potential disturbance is considered small in the context of the Humber Estuary SPA/Ramsar and the birds in this area only represent a very small proportion of the estuary-wide numbers that typically occur. 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 are relatively low and even relatively frequent disturbance only causes a small reduction 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 no construction activity is occurring.

9.8.195 However, as noted above, it is acknowledged that waders birds can show a high level of site fidelity, and 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.

9.8.196 It is also recognised that during very 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, RSBB, 2010; Collop *et al*., 2016).

9.8.197 In summary, the probability of disturbance occurring is considered to be high with frequent disturbance at a level which could cause dispersive responses and short-term and localised displacement of coastal waterbirds likely. Magnitude and consequently exposure to change is considered to be medium. The sensitivity of coastal waterbirds in the area is considered to range from low to medium depending on the species. Importance is considered to be high because of the protection afforded to coastal

waterbirds. Therefore, the impact of temporary disturbance during construction has, at this preliminary stage, been assessed as **minor to moderate adverse**.

Operational phase

9.8.198 Based on an understanding of the nature and scale of the proposed development, together with the environmental baseline and stakeholder comments provided in the Scoping Opinion, the potential effects during the operational phase that are currently considered likely to be relevant are reviewed in Table 9.19. This includes the rationale for scoping in or out individual pathways for further assessment. It should be noted that a high-level impact assessment has been provided with respect to maintenance dredging. Maintenance dredging for the proposed development will form part of the existing marine licence for the disposal of maintenance dredge material from the Port of Immingham (L/2014/00429/2). The predicted impacts on marine receptors as a result of maintenance dredging are considered to be comparable to the existing maintenance dredge regime. The magnitude of potential impacts are also considered either equivalent or lower than the capital dredge. On this basis, pathways relating to maintenance dredging have been assessed as **insignificant** and scoped out of a more detailed assessment.

Table 9.19. Potential effects during operation scoped in and out of further detailed assessment

Receptor	Impact Pathways/Potential Effects	Project activity	Included in 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 RoRo 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 Changes to habitats and species as a result of sediment deposition Indirect changes to seabed habitats and species as a result of changes to hydrodynamic and sedimentary processes	Maintenance dredge and dredge disposal	No	As summarised in the Physical Processes assessment (Chapter 7), it has been assumed that a level of maintenance dredging similar to that which is already afforded to the Immingham berths (including IGT, HIT, Bellmouth and East and West Jetty) will be required. Volumes of material from maintenance dredging (up to 220,000 m³ annually, to be dredged as required) of the IERRT berth pocket will be lower than those from the original capital dredge (330,000 m³). The frequency and volume of material deposited from each load will not change compared with current maintenance dredging activities as the same plant and methods are proposed to be used. Subject to no appropriate alternative use being identified for the maintenance dredge material, it is anticipated that any requirement for disposal of maintenance dredged material at sea associated

Receptor	Impact Pathways/Potential Effects	Project activity	Included in assessment?	Justification
	Changes in water and sediment quality Underwater noise disturbance			with the proposed development will be fulfilled at the Clay Huts licensed disposal site (HU060) as per the existing maintenance dredge licence. Consequently, 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. Furthermore, 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. Changes in water quality (as summarised in Chapter 8) are also expected to be lower than for the capital dredge and similar to existing maintenance dredging. On this basis, the predicted impacts on benthic ecology 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. 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 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 Changes in water and sediment quality Underwater noise disturbance	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 or lower than the capital dredge and comparable to the existing maintenance dredge regime. Potential effects associated with these impact pathways are, therefore, assessed as **insignificant** and have been scoped out of more detailed assessment.
	Underwater noise disturbance	Vessel operations	No	During the operational phase there is the potential for noise disturbance to fish species as a result of vessel movements. However, 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. This impact pathway has, therefore, been scoped into the assessment.

Receptor	Impact Pathways/Potential Effects	Project activity	Included in assessment?	Justification
Marine mammals	Underwater noise disturbance	Maintenance dredge and dredge disposal	No	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 or lower during maintenance dredging. The potential effect is, therefore, considered to be **insignificant** and has been scoped out of more detailed assessment.
	Underwater noise disturbance	Vessel operations	No	During the operational phase there is the potential for noise disturbance to marine mammal species as a result of vessel movements. However, 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. This impact pathway has, therefore, been scoped into the assessment.
Costal 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

9.8.199 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:

- Direct changes to benthic habitats and species beneath marine infrastructure due to shading;
- Changes to intertidal habitats and species as a result of the movement of RoRo vessels during operation; and
- Non-native species transfer during vessel operations.

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

General scientific context

9.8.200 Artificial shading 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).

9.8.201 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, including food web dynamics (Byers and Grabowski, 2014), sediment erodibility (Grabowksi *et al*., 2011) and biogeochemical properties of sediment (Murphey and Tolhurst, 2009). 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 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).

9.8.202 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).

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9.8.203 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.

9.8.204 The floating pontoons would be expected 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 could be observed in terms of a reduction in productivity but the broad faunal assemblage is likely to persist. Furthermore, highly turbid conditions in the Humber Estuary generally limits the amount of sunlight reaching the seabed and the area impacted will also be highly localised.

9.8.205 The open piled approach jetty and linkspan could cause some shading to intertidal mudflat habitat. However, given that these structures will be located several metres above the seabed, 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.

9.8.206 Based on the information provided above, the magnitude of the change is considered to be negligible. The probability of some shading considered to be high and the overall exposure is, therefore, 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 considered commonly occurring in the region, intertidal habitats are protected and of functional importance for waterbirds. Importance is

therefore considered to range from low (for subtidal habitats) to high (for intertidal habitats). Consequently, the overall impact is, at this preliminary stage, assessed as **insignificant.**

Non-native species transfer during vessel operations

General scientific context

9.8.207 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.

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9.8.208 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.

9.8.209 In view of current legislation (described in more detail in the assessment of non-native species during construction) 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 low to medium (for subtidal habitats). The overall impact is, therefore, assessed, at this preliminary stage, as **insignificant to minor adverse**.

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

General scientific context

9.8.210 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).

9.8.211 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).

9.8.212 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*., 1933; 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 a 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 boat traffic plays in mudflat dynamics and sediment fluxes.

9.8.213 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).

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9.8.214 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.

9.8.215 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).

9.8.216 Vessels transiting in coastal waters produce waves and generate currents associated with the passage of the hull through the water. A vessel travelling through the water generates a combination of both short period waves (referred to as ‘wake’ which propagates from the bow and stern sections of the vessel) and long-period waves which result in surface ‘drawdown.’ These waves are accompanied by turbulence generated by the vessel’s propulsion system, the magnitude of which is dependent on the type of propulsion and propeller used. The net effect is referred to as ‘shipwash’ and contributes, at times, to the overall wave energy regime.

9.8.217 Vessels approaching the floating pontoons will be approaching at slow speeds in order to allow berthing. This will keep potential 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 nearby to intertidal areas with no known significant erosional effects recorded.

9.8.218 On this basis, magnitude of impact and consequently exposure is considered to be negligible. Therefore, while 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** at this preliminary stage.

Coastal waterbirds

9.8.219 This section contains a preliminary 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 marine infrastructure; and
- Disturbance of waterbirds during operation.

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

General scientific context

9.8.220 Port and harbour development have the potential to cause direct damage or reduced functionality to waterbird feeding and roosting habitat due to port infrastructure. Coastal waterbirds are also regularly roost on a variety artificial structures in harbours and ports including pontoons, platforms, sea walls and dolphins (mooring structures) (Jackson *et al.,* 2021; Jackson, 2017). 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.

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9.8.221 Marine infrastructure associated with the proposed development (raised jetty structure, linkspan etc.) will not prevent any direct access to roosting habitat used by coastal waterbirds in the area. 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.

9.8.222 Based on the preliminary assessment of impacts on benthic habitats and species detailed above, the magnitude of the change based on the current project design is considered to be negligible. The sensitivity coastal waterbirds to direct changes to foraging and roosting habitat on the scale predicted is considered to be low to medium and thus vulnerability is considered to be none. Importance is high because of the protection afforded

to coastal waterbirds. Consequently, the overall impact is assessed as **insignificant** at this preliminary stage.

9.8.223 It is nevertheless acknowledged that operational disturbance has the potential to result in a potential reduction in the use by birds of habitats in the vicinity of the proposed development as discussed in the next sub-section.

Disturbance of waterbirds during operation.

Scientific context

9.8.224 The operational phase of ports and other coastal developments also provides a source of potential 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 cranes and cargo containers) (ABPmer; 2015; ABPmer, 2013).

9.8.225 In general, human presence on the foreshore (e.g. walking) is considered to cause greater disturbance than vehicles or watercraft (Glover *et al.,* 2015; Guay *et al.,* 2014; IECS, 2009a). Most 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 is factor of vessel traffic which can cause variation in waterbird response. Literature suggests that 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, 1998; Schwemmer *et al*., 2011).

9.8.226 Vessel movements and human presence around pontoons and jetties has the potential to cause a regular and often sustained source of visual and noise disturbance stimuli to birds on nearby foreshore habitat. However, empirical studies to try and quantify both short term disturbance and more permanent displacement effects due to vessel movements and human activity around port and other operational jetties and pontoons are generally limited due to a lack of long-term monitoring studies.

9.8.227 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 located 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).

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9.8.228 Operational disturbance stimuli could occur as a result of Ro-Ro vessel movements and people in and around the berthing infrastructure (floating pontoons, approach jetty, linkspans). The nearest berth will be located approximately 40 to 100 m to intertidal mudflat used by coastal waterbirds (following completion of the capital dredge).

9.8.229 The evidence reviewed above suggests that birds are less affected by defined regular movements of people 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 typical port operational activities (which are normally defined regular movements rather than more erratic activity). Furthermore, birds can also show limited disturbance to the movement of vessels providing they are generally moving at slow speed and in a predictable manner.

9.8.230 However, disturbance can occur as result of any human activity irrespective of habituation, if the activity occurs in close enough proximity to a species as to trigger a responsive reaction. Given that Ro-Ro vessels and human activity associated with operations will be occurring close to the foreshore (within 40 to 100 m), regular disturbance responses are considered possible. This is considered particularly the case initially when birds are more unlikely to be habituated to this new activity. Responses are expected to typically involve infrequent, mild behavioural responses in a localised area in the vicinity of the vessel or pontoon for most species. The responses observed 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 development). Rather than dispersing the area completely, birds would be expected to temporarily redistribute within the local area with birds regularly moving around the foreshore in this area to feed.

9.8.231 Based on the information provided above, the probability of some disturbance occurring is currently considered to be high with frequent disturbance at a level which could cause dispersive responses and potentially short-term and localised displacement of coastal waterbirds initially likely to occur. However, birds would be expected to become habituated over time which is likely to limit any longer-term disturbance responses to a relatively localised area around the pontoons. 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 medium depending on the species. Importance is high because of the protection afforded to coastal waterbirds. Therefore, the impact of temporary disturbance during construction has been assessed as **minor adverse** at this preliminary stage. However, it is acknowledged that there is some uncertainty with respect to the extent and rate of habituation given the close proximity of the pontoons to the foreshore. On this basis, an adaptive monitoring and mitigation strategy is proposed to be implemented (Section 9.9).

9.9 Mitigation measures

Loss of intertidal habitat

9.9.1 It is not possible, at this stage, to identify definitively whether there will be a need for ABP to provide compensation before the final project design is formalised and the scale of any potential loss of intertidal habitat is settled. Should any compensatory habitat be required to avoid significant adverse effects associated with the loss of habitat, however, this will be developed and agreed through ongoing engagement with the statutory authorities as part of the pre-application process.

9.9.2 If suitable replacement intertidal habitat is required, however, once the final scheme design has been settled, the potential effects of intertidal habitat loss on benthic habitats and species and coastal waterbirds would be considered at this preliminary stage as **minor adverse** and not significant.

Secondary mitigation

9.9.3 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 will be further developed if required through ongoing engagement with statutory authorities as part of the statutory consultation process. The final agreed mitigation measures will be submitted as part of the DCO application.

Underwater noise and vibration on fish and marine mammals as a result of construction

9.9.4 In order to reduce the level of impact associated with underwater noise and vibration on fish and marine mammals during construction (which was 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 protocols[11];
- **Vibro piling**: Vibro piling is proposed to be used where possible (which produces lower peak source noise levels than percussive piling) and is likely to constitute the majority of the piling operations. However, in order to drive the piles to the required design level in certain circumstances percussive piling may be required;
- **Piling restrictions:** The requirement for piling restrictions during sensitive periods for migratory fish will be discussed with the Environment Agency; and

[11] JNCC (2010). Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise.

- **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 a pre-defined radius (e.g. 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;
  - 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 an agreed period of time (suggested to be 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.

9.9.5 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 at this preliminary stage.

Disturbance to coastal waterbirds during construction

9.9.6 In order to reduce the level of impact associated with noise and visual disturbance during construction (which was assessed as minor to moderate adverse), the following mitigation measures will be implemented during construction:

- **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; and
- **Cold weather construction restriction**: Coastal waterbirds are considered particularly vulnerable to bird disturbance during periods of

extreme winter weather. 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.

9.9.7 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 at this preliminary stage.

Disturbance to coastal waterbirds (operation)

9.9.8 Given that there is considered to be some uncertainty with respect to the potential level of disturbance that will occur as a result of vessel and people movements around the pontoons near the foreshore it is recommended that an adaptive monitoring and mitigation strategy is implemented.

9.9.9 Coastal waterbird surveys will be undertaken twice a month from August to April based on the same sectors and approach as the IOH surveys for two years during operation. In addition, any disturbance observed during the surveys will be recorded based on the following criteria:

- **Level 1 disturbance**: No reaction by birds in the survey area;
- **Level 2 disturbance:** A small disturbance event in which birds are disturbed within 100 m of the proposed development boundary and then resettle rapidly within or near their original area after the disturbance passed/ended;
- **Level 3 disturbance:** A moderate disturbance event in which birds are disturbed up to 300 m from the proposed development boundary and then resettle rapidly within or near their original area after the disturbance passed/ended; and
- **Level 4 disturbance:** A large event in which birds are disturbed up to and beyond 300 m the proposed development boundary and then leave the area.

9.9.10 To help with interpreting data, it is proposed that the following categories are used to provide an overarching score per survey. Only disturbance events caused by activities related to the proposed development will be included within this assessment:

- **Green:** There was either no disturbance or a Severity Level 1 and 2 disturbance events observed once or twice during any survey;
- **Amber:** Severity Level 2 disturbance events occurred regularly (three or more times) during any survey, OR a Severity Level 3 disturbance event

occurred once or twice during any survey period, OR one Severity Level 4 disturbance event occurred during any survey; and
- **Red:** Severity Level 4 disturbance events occurred two or more times during any survey.

9.9.11 This approach is based on criteria that has been used to monitor disturbance at other operational pontoons.

9.9.12 In addition, abundance data will be compared against baseline numbers (collected as part of the IOH surveys) to understand if the abundances of key bird species are within the range of interannual variation or have shown a decline which might indicate potential displacement.

9.9.13 The results will be summarised as part of annual reports and discussed further with Natural England (including the requirement for any additional mitigation such as pontoon screening).

Tertiary mitigation

9.9.14 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**: 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 will be included within the CEMP 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 Chapter 3 Details of Project Construction and Operation, Section 3.3).

9.10 Limitations

9.10.1 This preliminary assessment has been undertaken based on the following assumptions:

- The current scheme design and project methodology, as detailed in Chapter 2 and 3 of this PEIR;
- Assessment of the effects of piling noise on fish assumes that fish swim passively with tidal flows as a worst case;
- Underwater noise assessment assumes that two piling rigs with impact hammers will be used concurrently as a worst case;

- Underwater noise assessment assumes that the dredging and vessel activity will take place continuously (24/7) and as such, provides a precautionary assessment; and
- Underwater noise assessment assumes that marine mammals will evade the noise source.

9.10.2 Whilst these are limitations, the assessment within this PEIR has been undertaken considering the anticipated worst-case scenario in respect of marine ecology receptors at the dredge, piling and disposal locations. The assessment will be updated in the ES to take account of the final scheme design and any further details on the construction methodology.

9.11 Preliminary Conclusions on Residual Effects

9.11.1 A summary of the impact pathways that have been assessed at this preliminary stage, together with the identified residual impacts and level of confidence is presented in Table 9.20

9.11.2 If suitable replacement intertidal habitat is required once the final scheme design has been settled, the potential effects of intertidal habitat loss on benthic habitats and species and coastal waterbirds would be considered at this preliminary stage as minor.

9.11.3 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.

9.11.4 Without mitigation, potential effects on these receptors were assessed as **minor to moderate adverse** and significant with the residual effects on these receptors assessed as **minor** and at this preliminary stage not significant following the implementation of the proposed mitigation measures.

9.11.5 All the potential impacts on nature conservation and marine ecology receptors have, at this preliminary stage, and based on the current proposals, been assessed as **insignificant to minor adverse** and, therefore, not significant.

Table 9.20. Preliminary summary of potential impact, mitigation measures and residual impacts

Receptor	Impact pathway	Impact Significance	Mitigation/compensation measure	Residual Impact	Confidence
Construction Phase					
Benthic habitats and species	Direct loss of intertidal habitat as a result of capital dredging and piles	Moderate	Provision of compensatory habitat	Minor	Medium
	Changes to benthic habitats and species as result of the removal of seabed material during dredging	Insignificant to minor		Insignificant	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 changes to benthic 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

Receptor	Impact pathway	Impact Significance	Mitigation/compensation measure	Residual Impact	Confidence
	Underwater noise and vibration disturbance 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	Medium
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 disturbance during piling, capital dredging and dredge disposal	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 Piling restrictions	Insignificant to minor	Medium

Receptor	Impact pathway	Impact Significance	Mitigation/compensation measure	Residual Impact	Confidence
Marine mammals	Underwater noise disturbance and vibration disturbance 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 mammals during percussive piling	Minor	Medium
Coastal waterbirds	Direct loss or change to coastal waterbird habitat	Minor to moderate	Provision of compensatory habitat	Minor	Medium
	Noise and visual disturbance	Minor to moderate	Apply soft start procedures during piling Cold weather construction restriction	Minor	Low
Operational Phase					
Benthic habitats and species	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 RoRo vessels during operation	Insignificant		Insignificant	Medium

Receptor	Impact pathway	Impact Significance	Mitigation/compensation measure	Residual Impact	Confidence
	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 marine infrastructure	Insignificant		Insignificant	Medium
	Disturbance of waterbirds during operation	Minor	Adaptive monitoring and mitigation	Minor	Medium

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9.13 Abbreviations/Acronyms

Acronym	Definition
AA	Appropriate Assessment
ABP	Associated British Ports
BAP	Biodiversity Action Plan
BEIS	Department for Business, Energy and Industrial Strategy
BNG	Biodiversity Net Gain
BTO	British Trust for Ornithology
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CIEEM	Chartered Institute of Ecology and Environmental Management
CRoW	Countryside and Rights of Way Act
cSAC	Candidate Special Areas of Conservation
D	Diadromous species
dB	Decibel
DCO	Development Consent Order
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
EC	European Commission
EcIA	Ecological Impact Assessment
EEC	European Economic Community
EIA	Environmental Impact Assessment
EMS	European Marine Site
ES	Environmental Statement
ES	Estuarine resident Species
EU	European Union
F	Freshwater species
FOCI	Feature of Conservation Importance
GB	Great Britain
HIT	Humber International Terminal
HMWB	Heavily Modified Water Body
HRA	Habitats Regulations Assessment
IECS	The Institute of Estuarine & Coastal Studies
IEMA	Institute of Environmental Management and Assessment
IERRT	Immingham Eastern Ro-Ro Terminal
IMO	International Maritime Organization

Acronym	Definition
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
LERC	Lincolnshire Ecological Records Centre
LGS	Local Geological Sites
LNR	Local Nature Reserve
LSE	Likely Significant Effect
LWS	Local Wildlife Site
MAGIC	Multi-Agency Geographic Information for the Countryside
MCAA	Marine and Coastal Access Act
MCZ	Marine Conservation Zone
MHWS	Mean high Water Springs
MM	Marine Migrant species
MMO	Marine Management Organisation
MPS	Marine Policy Statement
MS	Marine Straggler species
NBN	National Biodiversity Network
NE	Natural England
NERC	Natural Environment and Rural Communities
NPSfP	National Policy Statement for Ports
PAH	Polycyclic Aromatic Hydrocarbons
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
Ramsar	Wetlands of international importance, designated under The Convention on Wetlands (Ramsar, Iran, 1971)
REC	Regional Environmental Characterisation
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

Acronym	Definition
SCOS	Special Committee on Seals
SMRU	Sea Mammal Research Unit
SPA	Special Protection Area
SPL	Sound Pressure Levels
SSC	Suspended Sediment Concentrations
SSSI	Site of Special Scientific Interest
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TraC	Transitional and Coastal Waters
TSHD	Trailer Suction Hopper Dredger
UK	United Kingdom
WCA	Wildlife and Countryside Act
WeBS	Wetland Bird Survey
WFD	Water Framework Directive

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

www.abpmer.co.uk